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THESIS

THE FUZE INDUSTRIAL BASE AT NAVAL AIR WARFARE CENTER WEAPONS DIVISION, CHINA LAKE, CALIFORNIA

by

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The Naval Air Warfare Center Weapons Division (NAWCWPNS), China Lake, California, is responsible for the development and integration of missiles for the Navy. NAWCWPNS is experiencing problems in acquiring fuzes that meet Government specifications. The purpose of this study has been to identify and propose solutions to these problems. A survey was conducted to obtain data from fuzing community experts, and the problems and solutions so obtained are provided. The five principal issues covered in detail are: (1) decreases in the fuze industrial base, (2) ambiguous or faulty specifications, (3) the fuze acquisition award process, (4) contract performance, and (5) the adversarial relationtionships that exist between contractors and the Government. Conclusions are drawn and recommendations for enhancements to the fuze industrial base are provided.

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The Fuze Industrial Base at Naval Air Warfare Center Weapons Division, China Lake, California

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ABSTRACT

The Naval Air Warfare Center Weapons Division (NAWCWPNS), China Lake, California, is responsible for the development and integration of missile fuzes for the Navy. NAWCWPNS is experiencing problems in acquiring fuzes that meet Government specifications. The purpose of this study has been to identify and propose solutions to these problems. A survey was conducted to obtain data from fuzing community experts, and the problems and solutions so obtained are provided. The five principal issues covered in detail are: (1) decreases in the fuze industrial base, (2) ambiguous or faulty specifications, (3) the fuze acquisition award process, (4) contract performance, and (5) the adversarial relationships that exist between contractors and the Government. Conclusions are drawn and recommendations for enhancements to the fuze industrial base are provided.

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I. INTRODUCTION

A. FOCUS OF STUDY

The Department of Defense (DoD) acquisition of military weapons is contingent on a viable commercial industrial base. From 1982 to 1987, the quantity of commercial firms providing military weapons and services to DoD decreased from 118,489 to 38,007 contractors; this equates to a 67 percent reduction [Ref. 1:pp. 31-32]. This exodus of firms affects all military-related industries, including major industries such as shipbuilding, aerospace, ordnance, and electronics.

The focus of this thesis is the fuze industrial base for United States Navy missiles. Specifically, the research analyzes the diminished capacity of the fuze industrial base at the Naval Air Warfare Center Weapons Division (NAWCWPNS), China Lake, California. This study also reviews problems pertaining to fuze contractors and other Government agencies.

B. RESEARCH OBJECTIVE

The objective of this research is to identify and propose solutions to problems related to acquisition of fuzes at NAWCWPNS, and to understand the underlying causes of these problems. A synergistic approach to a review of the fuze acquisition process has been used. This approach both defines the difficulties associated with the fuze acquisition process

and also characterizes the interrelationships between issues and officials. The research has resulted in recommendations for corrective processes and improvement actions that are expected to help maintain a viable fuze industrial base.

C. RESEARCH QUESTIONS

The primary research question addressed in this study is: what are the key problems facing the fuze technology industrial base and how can those problems be resolved?

The subsidiary questions are:

- What are the causes of the decreasing fuze industrial base?
- Do Government specifications allow for contractor flexibility in designing and producing fuzes?
- What Government incentives or programs exist that encourage contractors to produce reliable, quality fuzes?

D. SCOPE AND LIMITATIONS

The scope of this study has been limited to the fuze industrial base as it applies to Naval Air Warfare Center Weapons Division and the fuze connection with Navy missile programs. NAWCWPNS is the Navy's primary laboratory for research, development, test, and evaluation of new air-launched weapons and weapon components. This thesis addresses fuze acquisition specifically as it relates to the research and development process at NAWCWPNS.

E. METHODOLOGY

The initial material for this study was obtained from a literature search conducted through the Defense Technical Information Center; Defense Logistics Studies Information Exchange; Dudley Knox Library at the Naval Postgraduate School; and interviews with NAWCWPNS engineers, Contracting Officers, contractors, senior military officers, and Program Managers. In addition, NAWCWPNS fuze contracts were reviewed and analyzed. Department of Defense industrial base studies were evaluated to assess past and current problems confronting the military industrial base. This analysis formed the foundation for the difficulties identified related to the DOD's industrial base. Based on this foundation, fuze studies and contracts were analyzed and interviews conducted to assess trends within the DoD industrial base in general and the fuze industrial base specifically.

A written survey was conducted to develop a core data base that could be used to answer research questions. The survey was administered to various experts in the fuzing community. Responses were cataloged by subject area, analyzed, and the results documented.

F. THESIS ORGANIZATION

Chapter II provides background information on the Naval Air Warfare Center Weapons Division missile fuze industrial base. Chapter III describes the acquisition process and

interrelationships among acquisition officials responsible for fuze contracting. Chapter IV is a narrative of fuze acquisition problems that occurred in the 1980s.

Chapter V identifies the survey methodology and research questions, and provides the resulting survey data. Chapter VI contains a summary of the data, conclusions, the data and recommendations both for action and further study.

II. BACKGROUND

A. INTRODUCTION

This chapter provides general information concerning the evolution, design, and operation of missile fuzes. A basic description of missile fuzes and their components is included to demonstrate the nature and complexity of fuzes. In addition, a description of the missile fuze industrial base is presented, plus the current status of vendor capabilities within the fuze industrial base.

The nature of missile fuzes requires that a strong research and development effort continually be directed toward improvement of fuze capabilities and reliability. This research and development effort is overseen by the Naval Air Warfare Center Weapons Division (NAWCWPNS). As the Navy's primary missile fuze research and development center, NAWCWPNS is responsible for the integration of missile and fuze components into viable missile systems.

The introduction of fuzes into projectiles began with early rifle munitions. But it was the proximity fuze development of the 1940s that drastically revised the traditional impact fuze to mechanically-controlled detonation. It was also the proximity fuze that provided the change from

Government-produced munitions and fuzes to contractor-developed and manufactured fuzes.

The solid fuze industrial base that existed in the 1950s and 1960s slowly eroded to a limited number of vendors who design and produce fuzes for the Navy today. In addition to the decline of fuze contractors, the reliability and quality of fuzes and fuze components has not been dependable. Because of both the decreased fuze industrial base and decreased fuze reliability, fuzes designed, developed, and procured by NAWCWPNS have been targeted for technological and developmental enhancement in the 1990s.

B. THE MISSILE FUZE INTERFACE

The purpose of the fuze is to detonate the missile warhead at the time and under the circumstances desired. The fuze is usually an electro-mechanical system capable of sensing or detecting the target, while the safety and arming (S-A) mechanism carries the initiatory explosive components and safety devices [Ref. 2:p. 134]. If the fuze fails to detonate, the missile essentially becomes a guided rock. If the fuze detonates prematurely, it will create serious safety hazards.

Missile designs have evolved to result in higher speeds, increased agility, and longer range capability. Unconventional missile shapes based on stealth technology are being incorporated into future missile designs. These changes

require intensified research and development in the areas of aerodynamics, subsonic and hypersonic flight, and the stability and control of tactical missiles. As a result, new demands are being placed on the design and reliability of fuzes. [Ref. 3:p. iii]

Research and development related to fuzes cuts across numerous Navy missile programs. The various types of missiles supported by NAWCWPNS research and development include anti-ship, surface-to-air, air-to-air, and air-to-surface missiles. NAWCWPNS has been responsible for developing missile systems such as Sidewinder, Harpoon, and Sparrow. In addition to a variety of missiles, NAWCWPNS is also responsible for a wide array of missile fuzes. A review of fuze design changes over time is provided below.

1. Historical Background

Fuze designs tend to be evolutionary; designs are changed incrementally in response to the technical or tactical environment. Prior to World War II, military projectiles relied on impact fuzes for detonation of the warhead. Impact detonation occurs when the projectile reaches the target and the force of impact triggers detonation.

During World War II, advances in aircraft design resulted in greater agility and speed of aircraft. This led to the development of the radio controlled proximity or timed fuze. As aircraft became faster, the probability of a direct

hit and resulting impact was greatly reduced. The following illustrates the situation.

> It could be shown (during World War II) that a high proportion of the shots passed within lethal distance of the aircraft but the timed fuzes of the period (even assuming them to have been correctly set) were not sufficiently reliable to guarantee bursting the shell inside the lethal radius. [Ref. 4:p. 4]

The proximity fuze required more components and greater complexity, when compared with the impact fuze. The proximity fuze was controlled by a clock that prevented the generation of a radio signal until a predetermined amount of time had passed. The emission of the radio signal caused warhead detonation. This control mechanism provided a means of detonating a warhead close enough to a surface or air target to allow the blast and particle emissions to destroy the target, even if the weapon did not strike it directly.

2. Current Technology

With the development of transistors and silicon diodes in the 1970s, fuze size could be reduced to meet the weight and size restrictions inherent in missile technology. There are two prevailing technical approaches to the design of proximity fuze timing devices. These are the mechanical fuze, which uses mechanical components for clock timer and has been in use for many years, and the electronic fuze, which uses digital components in the clock and has been developed in the last five years. Both techniques rely on the timing function

to detonate the warhead once the projectile is within lethal range of the target [Ref. 4:pp. 5-6].

Most fuzes actually fired between 1950 and 1990 have used the mechanical fuze technology. There are primarily two reasons for the predominance of mechanical fuses.

- Production Technology. Production of electronic fuzes requires state-of-the art, capital-intensive manufacturing procedures. The fuze industrial base is currently short of capability in this area.
- Fuze Interchangeability. Missiles in the current inventory are designed for use with mechanical fuzes, and development of an interchangeability capability is believed to be too costly.

In view of these restrictions, the use of mechanical fuzes is expected to continue into the next decade. Thus the fuze industrial base must support both technologies. The effort involved in providing this support can be better understood by reviewing the components that make up a fuze.

C. FUZES AND FUZE COMPONENTS

A fuze is defined as a device designed to initiate detonation of a warhead at a specific time or location. Because the fuze is a critical element in the missile, it is imperative that the fuze function properly during the life of the missile. Missiles can cost over a million dollars per unit, whereas the fuze may cost a few hundred dollars per unit [Ref. 5:p. C-4].

Fuzes are traditionally composed of three basic parts. Components are illustrated in Figure 1 below [Ref. 6:p. 5].

1. Sensor Assembly

The first fuze component includes a proximity and/or contact fuze. Primary initiation occurs when the sensor detects the presence, distance to, and/or direction of the target, either through the characteristics of the target itself or of its environment. [Ref. 6:pp. 5-6]

2. Safety and Arming Device

The S-A device keeps the ordnance section safe for handling and storage. It also arms the ordnance section at the proper time so it will detonate when the weapon nears or hits the target.

Because S-A devices are single-shot items, they cannot be fully tested or repaired. For acceptance purposes, the S-A device must be destructively tested using random sample techniques. S-A devices are required to have a life that is equal to the life of the weapon system in which they are deployed, a very low failure rate, and high reliability. Military Standard 1316 requires that "the safety failure rate shall not exceed one failure in one million prior to intentional initiation of the arming sequence." The safety and reliability requirements are critical, as the S-A device is the only safety element used on a warhead [Ref. 6:p. 5].

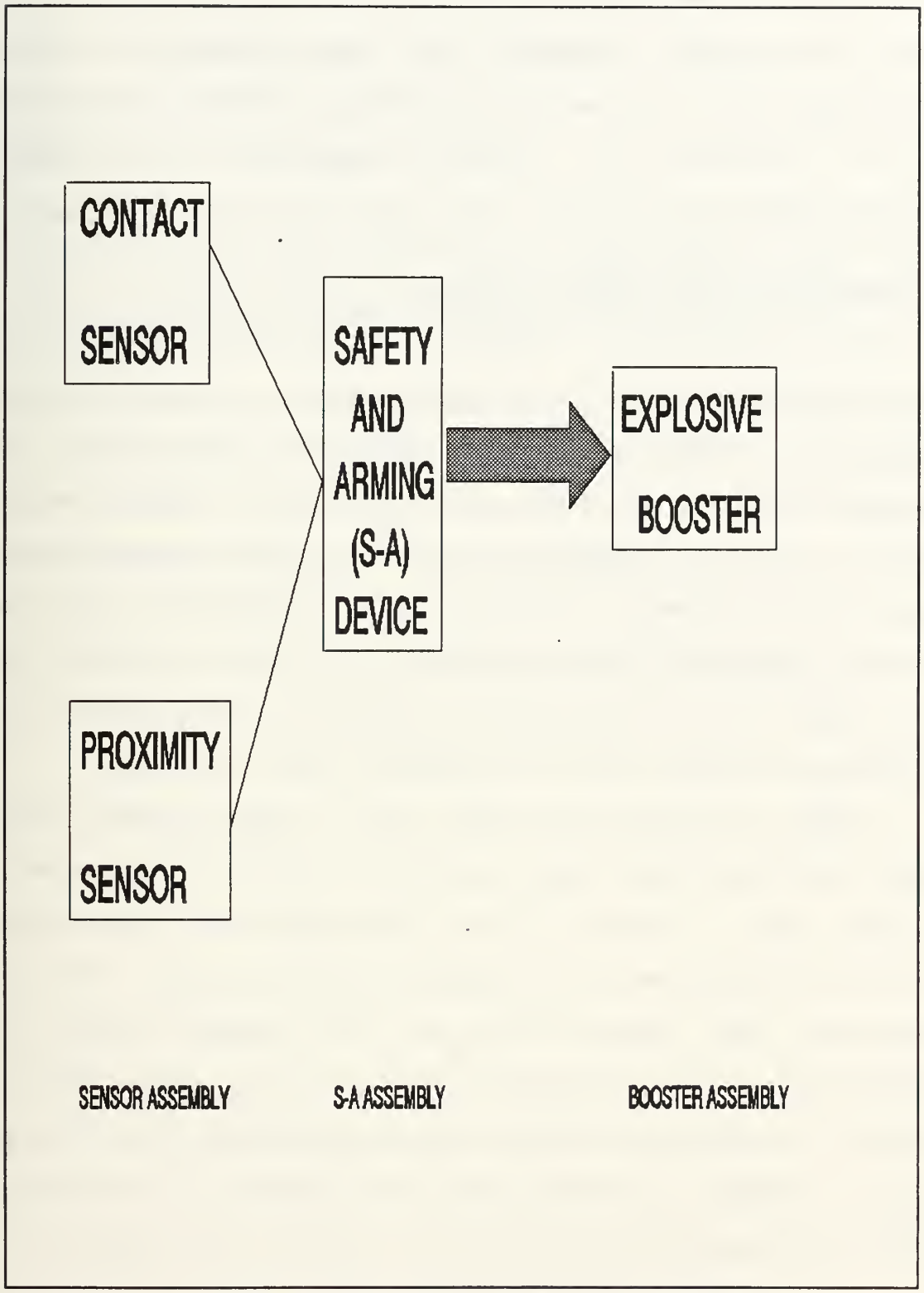

Figure 1. Three Components of a Fuze System.

3. Explosive Booster

The third component is the explosive booster. Detonation of the booster is initiated by output from the S-A device. The booster then initiates detonation of the warhead [Ref. 6:p. 5].

D. NAWCWPNS FUZE INDUSTRIAL BASE

During the 1950s and 1960s, NAWCWPNS had 18 contractors who provided fuzes and associated parts. As the defense budget was reduced in the late 1960s and early 1970s, the decreased demand for fuzes caused several contractors to abandon the fuze industrial base. A shift from multiple, competitive contractor awards to limited competition with few offerors became the norm at NAWCWPNS. In the late 1980s, the fuze industrial base decreased to only six primary sources who supplied mechanical fuzes to NAWCWPNS [Ref. 6:p. 12].

While adequate competition [two or more sources] could still be obtained for some programs, it did not guarantee a reliable fuze. Several of the remaining fuze contractors encountered problems in delivering reliable fuzes. The lot acceptance test failure rate for S-A devices reached an unacceptable rate of 43 percent [Ref. 7:p. 3]. This issue of reliability affected numerous missile programs, resulting in delayed shipment to prime missile contractors of Government Furnished Property in the form of completed fuze assemblies.

In addition to the reliability issue, the fuze industrial base is characterized by another significant change. Contractors now not only manufacture fuzes, but they design them as well. As noted in *Armada*,

> The remarkable thing about fuze manufacture today is that so much of it is carried on by commercial companies. Forty years ago fuze design and manufacture was practically a Government monopoly, commercial firms coming into it solely as manufacturing contractors. [Ref. 4:p. 7]

The U.S. Navy first contracted with Eastman Kodak during World War II to design and develop a proximity fuze. This began the trend toward commercial contractor involvement in the development of new fuze designs and specifications.

III. THE MILITARY ACQUISITION PROCESS

A. INTRODUCTION

The acquisition process and the acquisition team members are the keys to successful fuze development and production. The acquisition process can be lengthy, sometimes taking months or years to award a contract. Given the complexity of this process, it is easy to understand that communication problems and ambiguities sometimes arise in Department of Defense (DoD) contracting.

The DoD uses the Federal Procurement Process for acquisition of weapons and equipment. Regulations governing the acquisition system are covered in the Federal Acquisition Regulation (FAR) and in supplementary regulations and documents. A summary of the procurement process for large purchases is provided in this chapter, specifically from a Naval Air Weapons Center Weapons Division (NAWCWPNS) prospective.

The NAWCWPNS Procurement Department has unlimited procurement authority. This department has been organized to provide customer support procurement, rather than commodity buying. Each division provides small and large purchase support to dedicated customers. This specialized customer orientation gives the Technical Manager a centralized

procurement entity for setting and meeting contract requirements and allows for better understanding and teamwork between procurement and Technical Managers.

Figure 2 depicts the steps in acquisition process for large purchases, as these relate to NAWCWPNS procurement. The responsible action officials are also identified because it is important to understand the relationship between customer and supplier.

B. RESPONSIBLE ACQUISITION OFFICIALS

1. Program Manager Interface With NAWCWPNS

The Program Manager (PM) is defined by the *Defense Acquisition Management Policies and Procedures*, DoD 5000.2, as "a military or civilian official who is responsible for managing an acquisition program" [Ref. 8:p. 15-14]. The PM alone is responsible and accountable for the success or failure of a program. PMs can be designated for major weapon systems and for weapon component programs. For the purpose of this study, the term Program Manager is used strictly for the manager at a major system command level rather than at the field activity level such as NAWCWPNS. For NAWCWPNS systems, the PMs are primarily affiliated with Naval Air Systems Command (NAVAIR) and Naval Sea Systems Command (NAVSEA). The NAVAIR and NAVSEA PMs must rely on others for technical advice

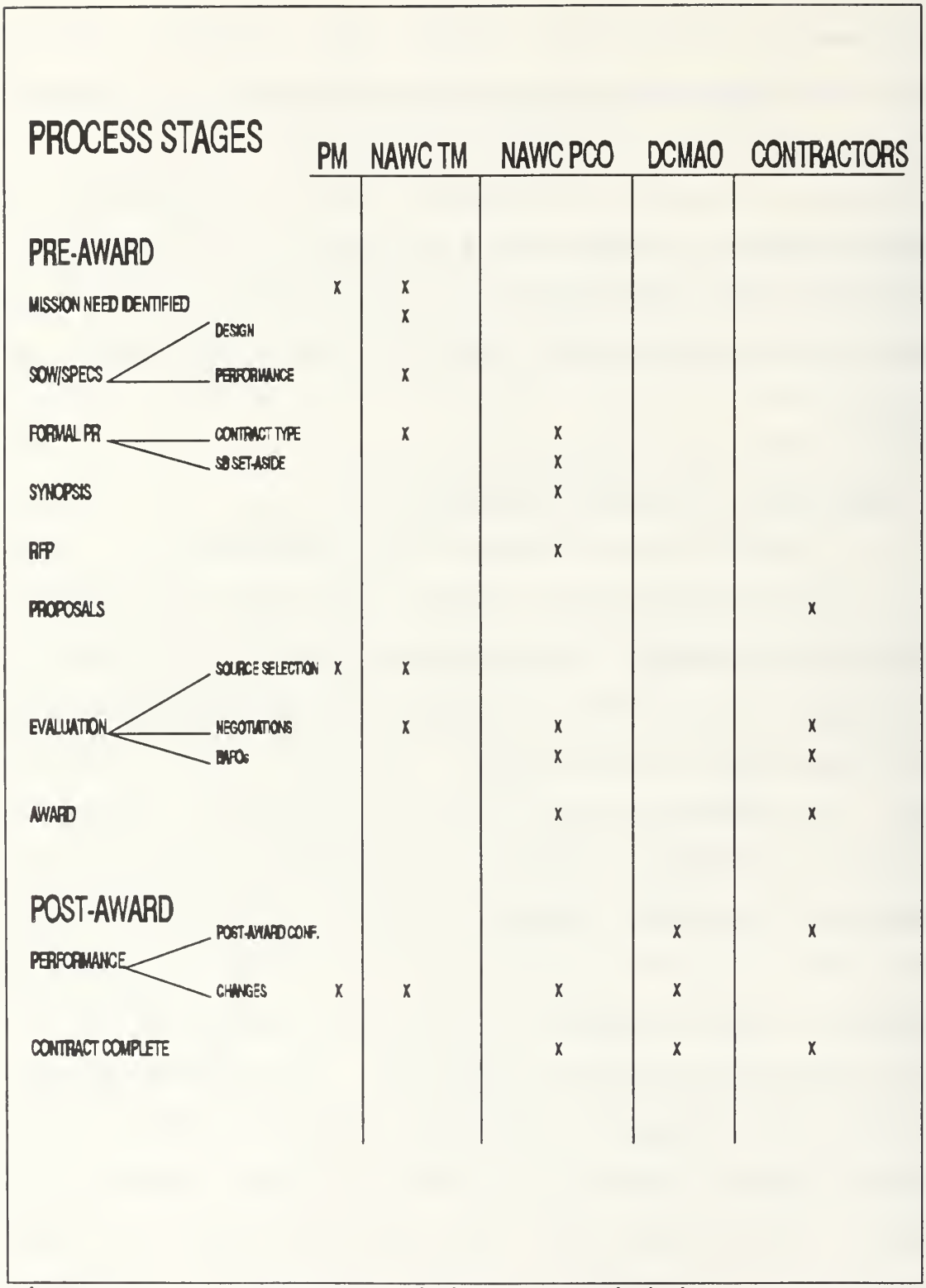

Figure 2. NAWCWPNS Military Acquisition Process for Large Purchases. Acronyms are provided in Appendix A.

and guidance. This required technical support often comes from Navy laboratories; in the case of fuzes, it primarily comes from NAWCWPNS.

The Navy maintains laboratories of acknowledged excellence in pertinent areas of science and technology. The laboratories develop and carry out scientific and technical programs which have as their prime objectives the improvement of naval capabilities, equipment, and systems [Ref 15]. Therefore, PMs rely on NAWCWPNS and contractors to provide reliable, quality fuzes. Problems at a field or laboratory level can greatly affect the major missile program itself, resulting in delays and increased costs.

2. NAWCWPNS Technical Manager

The Technical Manager (TM) is defined as the manager of a program at the field activity level. The TM can be an engineer, physicist, chemist, technician, or local delegated program manager associated with NAWCWPNS. The technical manager at NAWCWPNS provides technical advice and support to the PM. In addition, the TM is responsible for the pre-procurement documents such as

- Statements of Work (SOW)
- Specifications and DoD Standards
- Source Selection Plans
- Delivery Schedules
- Other-Than-Full-And-Open-Competition Justifications

- Purchase Requisitions (PRs)

The TM is often the first link in the procurement cycle, serving as the primary supplier of requisition requirements to the Procurement Department. Just as important, TMs are the primary customers of the procurement process. Therefore, the TMs and Procuring Contracting Officers must work closely together to ensure that the Government receives a quality, reliable product.

3. NAWCWPNS Procuring Contracting Officer

The Procuring Contracting Officer (PCO) carries the responsibility for assuring that the Government's minimum requirements are met throughout the acquisition process. The PCO has been delegated the written authority to contract for the Government. Neither the PM nor the TM can obligate the Government. The PCO is the responsible official who assures that the acquisition process is in compliance with Federal laws and regulations. The PCO is responsible for issuing the solicitations requests, conducting cost or price analyses, conducting and controlling all negotiations, and selecting the source for contract award. The PCO also must determine that a contractor is responsive and responsible, and that the price being offered to the Government is fair and reasonable. [Ref. 9:p. 1-14]

4. Administrative Contracting Officer

After the contract is awarded by the PCO, contract administration is normally assigned to an Administrative Contracting Officer (ACO). ACOs are located at or near to the contractor's facility and they provide Post-Award contract support. In addition, ACOs assure that DoD contract requirements are met. The ACO keeps the procuring activity appraised of contract progress and/or problems [Ref. 10:part 42.202].

5. Prime Contractors

The prime contractor is defined as "a contractor having responsibility for design, control, and delivery of a system or equipment such as aircraft, engines, ships, tanks, vehicles, guns, and missiles" [Ref. 10:part 42.2]. The prime contractor can be at a system or component level, that is, can be responsible for the missile or the fuze. For this study, the term prime missile contractor is used to designate the former. The prime contractor is determined by the acquisition award process. The Government relies on private enterprise systems to provide the needed military weapons and components.

6. The Acquisition Team

In the acquisition process, the principal players are the PM, TM, PCO, ACO, and contractor. However, many other officials also influence the acquisition process. Other participants may include the program's business or financial

manager, small business office, logistics requirements personnel, legal counsel, and Congressional representatives who request information. Understanding who is responsible for what in the acquisition process is as critical as the actual process itself.

C. ACQUISITION PROCESS: PRE-AWARD

1. Mission Need and Funding

All acquisition programs are based on identified mission needs [Ref. 8:p. 15-14]. The needs are generated as a direct result of continuing assessments of current and future capabilities in the context of changing military threats and defense policy. Once a need has been established, conceptual studies conducted, and approval granted, funding is then allocated for the Concept Demonstration process at Milestone I. A Program Manager is assigned within six months after a favorable decision for program implementation. In the case of missile development, the PM must determine whether to procure the entire missile system from a contractor or "break out" components such as fuzes for separate procurement. NAWCWPNS personnel include a wide variety of missile and fuzing technology experts. NAWCWPNS often provides technical assistance to the PM and the missile contractor. If the fuze is a "break out" item from the missile contract, then NAWCWPNS is routinely delegated responsibility for the development,

procurement, integration, and delivery of the fuze to the either the PM or the prime missile contractor.

2. Statements of Work, Specifications, and Standards

The NAWCWPNS TM is the principal agent in determining what type of Statements of Work (SOWs), specifications, and standards are required for the fuze. SOWs are written to define the tasks the contractor will carry out. SOWs can be separated into two categories: design and performance. Historically, NAWCWPNS fuze contracts have relied on design requirements rather than performance requirements.

Design requirements control development of the item by defining its design in sufficient detail to enable manufacture of a product conforming to military needs. The requirements include technical data that specify material composition, treatment, finish, chemical, physical, and electrical properties; fabrication and production; and other requirements necessary to ensure proper performance and manufacture [Ref. 11:p. 518].

Performance statements of work and specifications control development of an item primarily by establishing performance requirements that are supplemented by quality assurance provisions and form, fit, and function limits. Requirements are expressed in the form of output, function, or operation, leaving the details of the design, fabrication, and internal workings to the manufacturer [Ref. 11:p. 515].

3. Formal Procurement Request

Once the requirement has been determined and defined, the TM prepares the formal Procurement Request (PR). The PCO reviews the PR for funding data, signatures, and completeness of the TM's documentation, the SOW, and item specifications. In addition, the PCO works with the TM to determine the best contract type for the program. The two main types are fixed-price contracts and cost-reimbursement contracts.

a. Fixed Price Contracts

A Firm-Fixed-Price (FFP) contract is recommended for well-defined requirements that require the contractor to deliver an end item for a fixed price. Few changes in requirements should be expected in fixed price contracting. Contract award is normally based on the lowest price from an acceptable offeror. The contractor assumes the risk for contract completion. [Ref. 10:part 16.2]

During the 1980s, former Secretary of the Navy John Lehman advocated fixed price rather than cost contracts for developmental efforts. NAWCWPNS awarded several fixed-priced fuze development contracts during the 1980s. Some of the fixed-price fuze development contracts that were awarded by NAWCWPNS during this time period are discussed in Chapter IV.

A Fixed-Price Incentive (FPI) contract is preferred when the contractor's assumption of a degree of cost responsibility will provide an incentive for cost control and improved performance. The Government and the contractor must be able to make a reasonable estimate of the costs and performance risks. The two parties must negotiate at the outset a firm target cost, target profit, and profit adjustment formula that will provide a fair and reasonable incentive, along with a ceiling that provides for the contractor to assume an appropriate share of the risk [Ref. 10:part 16.403]. NAWCWPNS has awarded FPI contracts for fuze development and limited production.

Other types of fixed-price contracts are permitted under FAR Part 16. However, FFP and FPI are the main fixed-price contract types that have been utilized by NAWCWPNS.

b. Cost Contracts

Under cost-type contracts, the contractor is required to provide the company's best efforts in performing the required work. Cost contracts are used where the risk cannot be reasonably estimated for the work to be accomplished, as is necessary for any type of fixed-price contract.

A Cost-Plus-Fixed-Fee (CPFF) contract is recommended for development efforts that pose a very great risk for the contractor. CPFF is used when there is a high

degree of uncertainty involved in estimating costs and technical risk. The contractor is paid allowable, actual costs plus a preset fixed fee. The contractor must provide the company's "best efforts" to complete the contract. With a CPFF contract, the Government may or may not receive a final product. The Government bears the risk for completion. [Ref. 10:part 16.306]

The Cost-Plus-Incentive-Fee (CPIF) contract is a type of cost-reimbursement contract that establishes a target cost, target fee, minimum and maximum fees, and a fee adjustment formula [Ref. 10:part 16.404-1]. A CPIF contract is recommended for development contracts. However, additional time is required for contract administration, for documentation of the costs, and for fee tracking, by both DoD and the contractor. CPIF contracts have not been used for fuze contracts at NAWCWPNS.

Under Cost-Plus-Award-Fee (CPAF) contracts, the contractor receives payment for actual costs plus an award fee. The advantage of using a CPAF contract is that the contractor receives an award fee based on performance. Federal Acquisition Regulation Subpart 16.404-2 states that the "award fee should be used to motivate the contractor in excellence in quality, timeliness, technical ingenuity, and cost-effective management" [Ref. 10:part 16.404-2].

CPAF contracts require additional contract administration for monitoring contractor performance. A

designated award fee board is established to allocate the share of award fee the contractor will receive. The award fee is normally paid quarterly and therefore the board must ascertain the contractor's level of performance each quarter. Because of the extra administration effort involved in CPAF contracts, policies were issued that precluded using CPAF for contracts of less than $25 million [Ref. 12]. This high dollar threshold has prevented NAWCWPNS fuze contracts from being written as the CPAF type.

4. Small Business Set Aside

The next step in the acquisition cycle is determining if the award will be set aside for small businesses. All contract requirements are required to be reviewed by the PCO and the Government's Small Business Representative to determine if the contracts should be awarded only to a company that is designated as a small business. If the item has been acquired successfully from a small business in the past, then all future requirements for that product must be considered small business set-asides, if two or more small businesses are deemed capable of meeting the requirements at fair market prices [Ref. 10:part 19.501]. No large business may compete when a procurement has been set aside for small businesses. Historically, several fuze acquisitions at NAWCWPNS have been set aside for competition among small businesses [Ref. 13].

5. **Synopsis**

Details concerning all acquisitions greater than $25,000 must be published in the *Commerce Business Daily* (CBD) unless this requirement is waived in accordance with FAR 5.202 [Ref. 10:part 5.2]. The CBD process provides prospective contractors with notification of a planned Government contract and allows contractors to submit a request to the PCO to be included in the list of prospective offerors.

6. **Request for Proposals**

The Request for Proposals (RFP) can be distributed to all interested contractors 15 days after the CBD notification is published. The RFP describes the delivery schedule, type of development work to be accomplished, number of units required, testing requirements, technical data, security classification, criteria for source selection and contract award, and other Government legal requirements. Contractors generally are allowed a minimum of 30 days to prepare and provide proposals to the Government; for research and development contracts the FAR sets a minimum of 45 days for offer submittal [Ref. 10:part 5.203]. Most NAWCWPNS fuze contracts are for research and development efforts; thus the proposal period is usually 45 days or longer.

7. **Contractors' Proposals**

Contractors who are interested in performing work for the Government must submit a proposal by the due date cited in

the RFP. Each contractor's proposal is evaluated in accordance with the criteria established and documented in the RFP.

8. Proposal Evaluations

Each contractor's proposal is independently evaluated to determine whether it is acceptable or not acceptable, according to criteria listed in the RFP and the Source Selection Plan. Since requirements differ from acquisition to acquisition, the source selection criteria are tailored to fit each acquisition. The two most common methods for selecting the source are referred to as the *low, technically acceptable offeror* and *best value*.

The *low acceptable offeror* is determined by the TM, who determines whether each offeror can meet the technical requirements set forth in the RFP and SOW; this process is often called *Go* or *No-Go*. Based upon the TM's recommendation, the PCO then determines whether the contract award is fair and reasonable and that the contractor is responsive and responsible [Ref. 10:part 14.407-2]. Under the *Go/No-Go* evaluation, the lowest acceptable offeror is awarded the contract.

Best value is another source selection technique used for contract awards. A *best value* selection is the proposal that provides the greatest value to the Government in terms of performance, cost, and other factors. *Best value* awards

normally include evaluation criteria such as technical approach, quality, contractor's management, meeting schedules, past performance, and cost realism.

The PCO and the TM work closely together to set up measurable evaluation criteria. The contractor is informed in the RFP what criteria are considered most important, in descending order of importance. Contractors prepare their proposals with the recognition that the lowest price or cost may not be the best value for the Government, given other factors.

The TM organizes a source selection team to evaluate the offers and recommends a list of acceptable offers to the PCO. The PCO determines the contractors whose offers fall in the competitive range; that is, offers which are acceptable or can be made acceptable based on technical, price, cost, and other salient factors [Ref. 14:p. B-2]. The PCO and TM then determine whether there are issues to be discussed with contractors via the negotiation process. If negotiations are opened, contractors must submit a Best And Final Offer (BAFO). After BAFOs are received, the final award decision is made by the PCO.

9. **Contract Award**

The PCO may award the contract immediately if there were no changes to the RFP after its publication. If changes were made during the evaluation or negotiation process, the

PCO must revise the contract and get a final signature from the contractor. The PCO also must determine that adequate contract funding is available prior to award. The PCO then signs the document. Once the contract is signed, the PCO can request assistance from the ACO in administration of the contract.

D. ACQUISITION PROCESS: POST-AWARD

1. Post-Award Conference

After the contract has been awarded, a post-award conference is held at the contractor's facility. The purpose of the post-award conference is to go over the terms and conditions of the contract before the contractor begins work. The ACO is responsible for initiating the post-award conference. The conference should be attended by the PCO, TM, appropriate contractor personnel, ACO, PM (if needed), and other appropriate Government officials such as the small business representative and legal counsel.

2. Performance Monitoring

At award, the contractor is responsible for performance, item delivery, and compliance with the contract terms and conditions. If the contractor or the Government requires a change to the contract, this can be accomplished in several ways. These include bilateral or administrative modifications, engineering change proposal requests, waivers, deviations, and change orders. If a contractor is

non-compliant in meeting contract requirements, the Government has the unilateral right to terminate the contract for default. However, the contractor does not have the right to terminate the contract if the Government breaches the agreement. The Defense Production Act requires contractors to carry out their agreements under DoD contracts. The Government is considered a sovereign entity and therefore laws were enacted to protect the Government's unilateral rights.

3. Contract Completion

Before a contract can be completed, the contractor must deliver all the hardware, software, and data required in the contract. The delivered items must be in compliance with the specifications and other contract requirements. The acceptance of hardware and data can be critical to both the Government and contractor. Once the Government accepts title to the property, the contractor no longer is responsible for the product.

IV. FUZE CONTRACTING ISSUES

A. INTRODUCTION

Will the U.S. have the technology and the skilled labor force to provide the military with state-of-the art missiles and weapons needed in the future, as the military industrial base continues to shrink? This chapter discusses three acquisition issues that strongly affect both the Government and its missile fuze industrial base. These issues are summarized below.

- Government specifications
- Awarding fixed-price development/low rate production contracts
- Adversarial atmosphere in the Government procurement system

B. INDUSTRIAL BASE ISSUES

Several general issues that affect the overall national industrial base also affect the fuze industrial base. A brief summary of some of these general and fuze-specific issues as reported in the literature are discussed below.

1. National Industrial Base Issues

According to Dr. David V. Lamm, the principal reasons companies refuse to participate in Defense business are:

- Burdensome paperwork
- Inappropriate Government bidding methods
- Inflexible procurement policies
- More attractive commercial ventures available [Ref. 15:p. 88]

The Under Secretary of Defense (Acquisition) suggests that there are ten underlying causes for problems in the Defense Industrial Base.

- Program and budget instability
- Absence of market incentives
- DoD procurement policies
- DoD organization for acquisition management
- Emphasis on competition
- Product and process specification
- Life cycle costing [rarely used]
- Lack of reliable subcontractors and suppliers due to full and open competition rules passed on to prime contractors
- Contract administration
- Management issues [Ref. 16:p. 32]

In a related study, the Defense Systems Management College (DSMC) sent out 831 questionnaires to industrial firms. DCMC received 244 written responses, and conducted 50 follow-up interviews with the respondents. This study found seven areas where there was a significant level of dissatisfaction concerning conducting business with the DoD.

- Procurement policies
- Audit procedures
- Bidding methods
- Late payment
- Government attitude/competence
- DoD specifications
- Profitability [Ref. 17:pp. 1-5]

2. Fuze Industrial Base

The fuze industrial base has experienced specific problems that mirror the national issues described above. In 1990, an industry and DoD workshop was held to determine problems facing the fuze and safe and arming device industries. This workshop was conducted by DSMC for the Office of the Deputy Director of Defense Research and Engineering. The top 15 problems that were identified were

- Need to use *best value* contracting versus accepting the lowest bidder
- Limited Government technical base funding for fuze development
- Lack of production requirements
- Lack of funds for facilities
- "Build to print" data packages, with no contractor flexibility in the design
- Ambiguous specifications and regulations
- Inability to prevent underbidding the contract [*buy-ins*]

- Adversarial relationships between Government and contractors
- Failure to initiate S-A device development early in weapon systems development
- Exhaustive, continual audits for compliance
- Decisions about fuzes made by prime contractors and program managers who have not consulted fuze technical and production experts
- Evolution of unrealistic Government planning and contractor bidding
- Dilemma of cost/completion advocacy overriding technical judgment in establishing qualified sources
- Unrealistic approach to second and multi-source competition [Ref. 18:p. 6]

As can be seen from these extensive studies and findings, several topics continue to threaten the fuze industrial base. This study will concentrate on the following recurring issues related to the fuze industrial base.

- Faulty and ambiguous fuze specifications
- Government emphasis on competition and fixed price contracts
- Government and contractor adversarial relationships

The following examples illustrate specific problems in the development, procurement, and timely delivery of reliable fuzes at NAWCWPNS in the 1980s. The information provided is a result of the analysis of ten fuze contracts and interviews with 16 Contracting Officers, scientists and engineers, legal

officers, contractor representatives, and Naval officers, as listed in Appendix B.

C. GOVERNMENT SPECIFICATIONS AND AMBIGUITIES

1. Engineering Change Proposals

In designing and developing fuzes for production, NAWCWPNS contractors and technical managers often need to modify the original requirements. These changes can be a result of new technology, ambiguous specifications, errors, or changes in anticipated missions or threats. The contractor is entitled to an equitable adjustment for changes which affect the form, fit, or function of the contractual requirement. The equitable adjustment can be in the form of additional costs and extensions in delivery schedule.

Historically, NAWCWPNS fuze contracts have relied on design specifications that require contractors to build the fuze exactly as stated in the Government documents. With no latitude to change the design specification, the contractor must submit to the Contracting Officer an Engineering Change Proposal (ECP) for every design change that affects dollars or schedule. These changes may require two levels of Government review and approval. At the fuze component level, the NAWCWPNS Engineering Change Board approves the change. If a change affects the primary missile program, the design change must also be approved by the Program Manager's office in Washington, D.C. This engineering change control process is

designed to enable the Government to maintain control over the configuration and documentation of weapon systems and components.

The lengthy and cumbersome ECP process causes delay and disruption in the work, pending change approval. Some ECPs have taken several months for approval and inclusion in the contract. This delay forces the contractor to take one of three actions.

- Continue working at the company's risk, assuming ECP approval will come
- Perform other work, if possible
- Stop work on the contract

As a change is incorporated by the Government, the drawing package must be changed to reflect the new design. The design package modifications are necessary so that the Government will have a documentation package that can be used for future competition and product maintenance.

2. Change Orders

Another method for implementing changes to a contract is by a unilateral change order issued by the Contracting Officer. Government contracts contain a clause that allows the Contracting Officer to make such changes within the general scope of the contract. The three areas where unilateral changes may be employed are:

- Drawings, designs, or specifications when the supplies to be furnished are to be specially manufactured for the Government in accordance with the drawings, designs, or specifications
- Method of shipment or packing
- Place of delivery

If the change causes an increase or decrease in contract price or delivery schedule, the contractor is entitled to an equitable adjustment to the contract. [Ref. 10:part 52.243]

Change orders can be negotiated at the time of issuance or an estimated "not to exceed" amount can be specified. In the later case, the contractor performs work under the change while assessing its cost and effect. One advantage of issuing an unpriced but estimated change is that the contractor can continue working without disruption. Under a stop-work scenario, the Government is liable for any Government-caused delay and disruption.

A unilateral change order leaves both the contractor and Government at risk. The risk for the contractor is in incurring costs for which reimbursement may be denied later if the costs are determined unallowable. The Government risk is that all actual allowable costs may have to be paid, even if the Government finds the contractor's business judgment questionable in implementing the change.

The following case demonstrates some of the problems in issuing unilateral change orders and in using a Fixed Price

Contract when the item's design has not been proven. Fictional names, contract numbers, and fuze models are used in this example (and in all subsequent ones). This case resulted in an adversarial relationship between various Government representatives, with respect to the execution of the unilateral change. An adversarial relationship also resulted between the Government and contractor because the claim was not resolved in a timely and efficient manner.

3. The XYZ Change Order Claim

NAWCWPNS awarded a multi-million dollar, Firm Fixed-Price contract to contractor XYZ for the development and limited low-rate production of fuze model 555. This sole source contract, N60530-00-C-0002 was based on the contractor's expertise since they were the only source that could perform the needed development fuze work. The contractor had received the previous design contract for the 555 fuze. The Government had validated the drawings and designs submitted under N60530-00-C-0001 and used the drawings and designs as the basis for N60530-00-C-0002.

In the case of *U.S. versus Spearin*, 1918, the court ruled that "if a contractor is bound to build according to plans and specifications prepared by the owner, the contractor will not be responsible for the consequences of defects in the plans and specifications" [Ref. 19: p. 327]. When XYZ company experienced problems with the design, several no-cost waivers

and deviations were submitted. When this did not eliminate the problem, an ECP was initiated at an estimated cost of $1 million. The NAWCWPNS Procuring Contracting Officer (PCO), in conjunction with the Technical Manager (TM) and Program Manager (PM) for this program, issued a unilateral change order with a "not-to-exceed" amount of $500,000. The contractor continued working and incurring costs. After several attempts, a successful solution to the fuze problem was finally found.

The contractor submitted an additional $2.5 million claim for the changes, stating that the Government had defective specifications in the Navy's "build to print" design contract. The claim took over two years to settle, at an increased cost of $3.1 million over the original contract.

In this situation, the contractor was frustrated because it took several years to resolve the claim. The contractor originally received only a portion of the incurred costs, the $500,000 change order, while the company's own capital was used to complete the design changes. In interviews, the NAWCWPNS TMs, PCOs, and contract specialists expressed disappointment concerning the contractor's apparently poor business judgment in implementing changes, and the additional $3.1 million cost on a fixed price contract. The XYZ company and thus the Government experienced schedule delays. In addition, both organizations incurred additional

costs and manpower expenditures in implementing and negotiating the changes.

After the changes were successfully implemented, the contractor delivered the model 555 fuzes under contract 0002. Under a later fixed price production contract, XYZ Company delivered several thousand model 555 fuzes prior to the delivery date set in the contract and without further design problems.

Through the process of negotiations, the claim was settled without litigation. The parties agreed that some of the specifications were faulty and ambiguous. In accordance with legal precedence, the contractor was entitled to the $3.1 million equitable adjustment.

The 1980s philosophy of using fixed price contracts for development was that the Government would know the price of the contract and therefore cost overruns would not occur. Neither the Government nor the contractors could foresee the extent of claims and problems that can arise from using fixed price development contracts. These claims were often the result of the design specifications not being complete prior to issuance of the fixed price contract. Currently, the use of fixed price development contracts is discouraged. In the case where development work will exceed $10 million, the PCO must get prior approval from Under Secretary of Defense (Acquisition) to use a fixed price contract [Ref. 20:p. 9].

D. FIXED PRICE DEVELOPMENT/PRODUCTION CONTRACTS

1. Awarding to the Low Offeror

The Competition In Contracting Act was passed in 1984. The purpose of this act was to assure that competition was given first consideration in awarding Government contracts. Simultaneously, fixed price development contracts were promoted by U.S. Navy, resulting in policies that encouraged the use of full and open competition, fixed price development contracts. Theoretically, the Navy would receive products at minimum prices via the competition process. Unfortunately, the life cycle cost, that is, the total cost to the Government for the development, acquisition, operation, and logistic support of a system over a defined life span, was not factored into the equation for competitive price awards. [Ref. 9:p. J-7]

With fuze development and limited production contracts, NAWCWPNS writes the SOW specifications at a preliminary level. The contractor is tasked through the contract to enhance the design and producible characteristics of the fuze component. Therefore, both the contractor and the Government expect that engineering design changes will occur during the development and low-rate-production phases of contract performance. With fixed price contracts, the contractor must accurately estimate the quantity and complexity of anticipated changes. When design or

reconfiguration changes are estimated incorrectly under fixed price contracts, the contractor may be forced to operate at a loss. The company can submit a claim for an equitable adjustment or provide a lower-priced, poorer-quality component.

2. ABC FFP Contract Default

Since mechanical fuzes are complex and intricate, NAWCWPNS has experienced several contractual and production problems under the fixed price contracting process. In the following case, ABC company, a small business, was awarded a fixed price contract for low rate production of fuzes. When the contractor encountered problems passing lot acceptance testing, the company did not have the financial capital nor manpower resources to resolve the difficulties in the performance of the contract.

The Phoenix missile was redesigned in the late 1970s to provide the Navy with an all-weather air defense missile for use against supersonic missile and aircraft targets, operating from sea level to 100,000 feet and out to 100 miles in any direction from the patrolling aircraft [Ref. 21:p. 195]. The FSU-10A fuze was to be a part of this upgrade to the Phoenix AIM-54C missile. The fuze was to be provided as Government Furnished Property (GFP) to the prime missile contractor via the NAWCWPNS firm-fixed-price contract. The Federal Acquisition Regulation clause concerning GFP states

> The Government shall deliver to the contractor, at the time and locations stated in this contract, the GFP described in the Schedule or specifications. If that property, suitable for its intended use, is not delivered to the contractor, the Contracting Officer shall equitably adjust affected provisions of this contract in accordance with the Changes clause. [Ref. 9:part 52.245-4]

NAWCWPNS was responsible for timely delivery of reliable Government-furnished fuzes to the prime Phoenix missile contractor. A limited advanced development, low-rate-production fixed price contract was awarded to ABC Company on a sole source basis for the Phoenix fuzes. When the ABC facility experienced an explosion related to the fuze, the company declared that the existing design was not producible. NAWCWPNS formed a team of fuze and contracts experts to assist ABC in resolving fuze production and delivery problems. After three years, ABC continued to experience fuze failures during testing.

During this time of production difficulties, the contractor was operating at a financial loss. NAWCWPNS finally terminated the ABC contract for default because of the company's failure to deliver [Ref. 22]. Shortly after the termination-for-default order was issued, ABC filed for bankruptcy. In this case, the Government could not provide the GFP fuzes to the prime missile contractor, forcing the prime contractor to deliver missiles without FSU-10 fuzes. ABC company is no longer in business, resulting in a decrease in the fuze industrial base.

Default of the ABC contractor caused disruptions at NAWCWPNS and for the Naval Air Systems Command Program Manager. The prime missile contractor was not receiving fuzes on a regular basis, which resulted in delinquent missile shipments. Several Phoenix missiles were delivered without fuzes and had to be retrofitted with the earlier fuzes to operate. At the present, a second contractor is trying to produce the mechanical-type fuzes. These fuzes are no longer provided as GFP to the prime missile contractor. The responsibility for obtaining acceptable fuzes now is placed at the prime contractor level. Only one source is available, and it has not yet qualified for fuze production. The sole source subcontractor must be qualified by the Government, which equates to prime missile contractor reliance on the Government for subcontracted fuzes.

3. Electro-Mechanical Fuze Technology

Fuzes have been made in the same manner for the past 20 years. Most 1980s fuzes used a mechanical-type technology that requires craftsmen very skilled in development and assembly of mechanical components. The primary technical difficulties encountered by ABC company were centered on the application of electro-mechanical fuze technology to the design and production of the FSU-10 fuze.

The difference between mechanical and electrical components can be explained by a simple analogy. The Swiss

are noted as producing high-quality mechanical watches. These mechanical watches require skilled artisans to assemble the multitude of mechanical parts properly. In the late 1970s, digital watch technology was developed and the use of robotics in manufacturing was initiated. Well-made digital watches now were less expensive, more accurate, and more reliable than most mechanical watches. The old fashioned mechanical watch now has become a high-priced luxury item. Robotics and digital circuitry resulted in devices that were cheaper and often more reliable than those with hand-crafted parts.

Fuzing and S-A devices are similar to the mechanical watch, as illustrated in Figure 3 [Ref. 23]. Mechanical fuzes require multiple moving parts that must be precisely assembled in order to function correctly. For many years, the primary fuze contractors also were clock manufacturers who were expert in mechanical watch technology. The feasibility of using digital circuit technology and robotics for fuze production has been tested only on a limited scale and only in the past two years. Thus, the Government still requires some mechanical fuzes in the military's state-of-the-art missiles. As with watches, mechanical fuzes are harder to produce because of the number of moving parts that require assembly by skilled craftsmen.

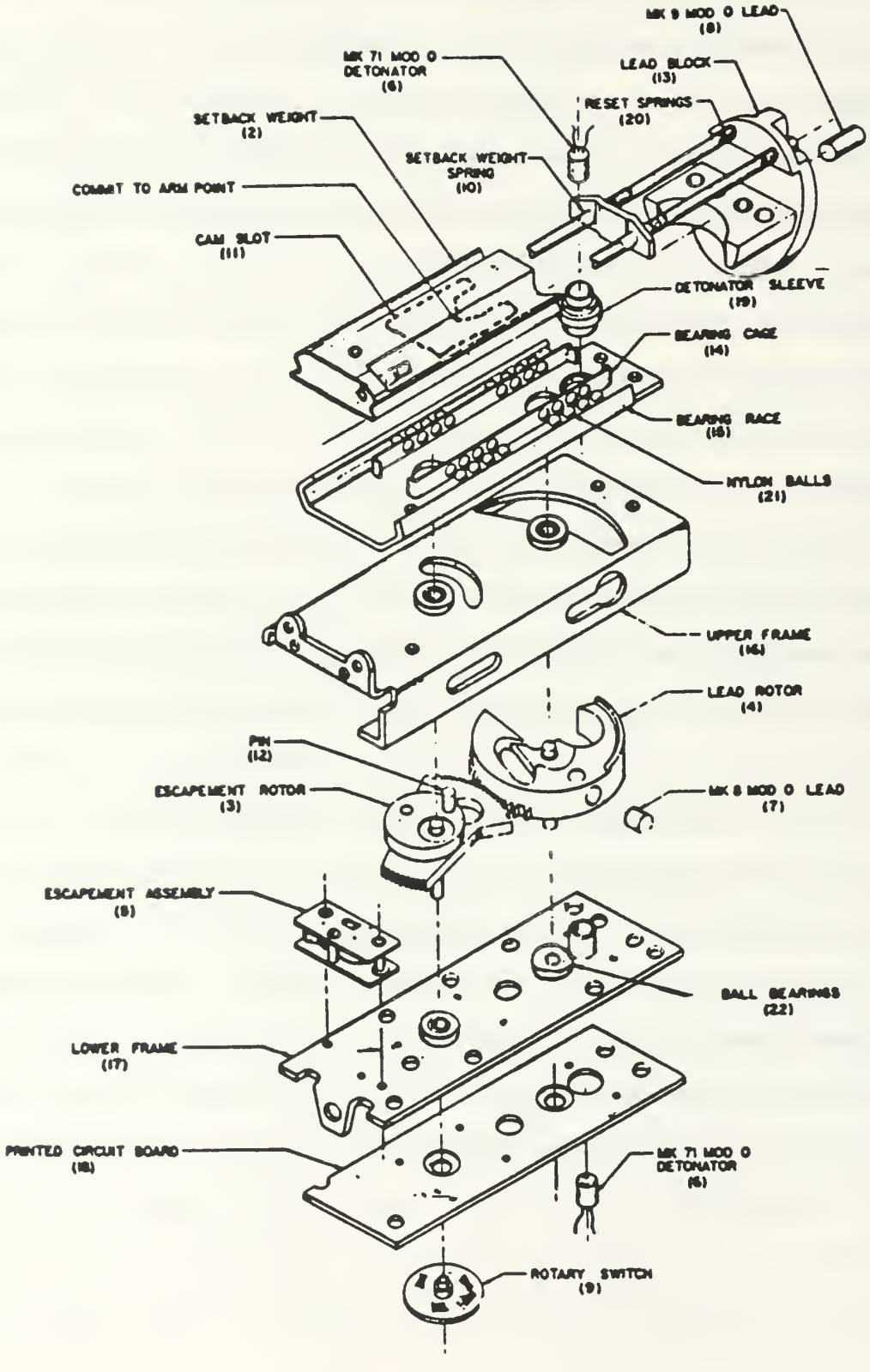

Figure 3. Components of an Electro-Mechancial Fuze

Lot acceptance test failures have uncovered several problems: mechanical interfaces, frictional problems, non-conforming parts, non-standard mechanical parts, and broken wires and parts [Ref. 24:p. 3]. Large businesses have not been willing to invest in equipment for unproven electronic circuitry for uncertain Government programs. Small businesses do not have the financial resources to invest in expensive robotics.

Fuzing technology issues have presented a new set of issues that the DoD must consider. For contractors to invest capital in new technology, the program must be considered stable. Changes in allocation and appropriations to the DoD's budget affects contractor resources and willingness to risk investing in potential programs. The need to update fuzing technology is evident.

E. GOVERNMENT AND CONTRACTOR ATTITUDES AND COMPETENCE

The Federal procurement process can create an adversarial atmosphere between the Government and contractor. The contractor must determine what product information is important to the Government and estimate the price or cost of the project. Yet the contractor must remain competitive with others in the field in order to receive an award. Often the Government selects the contractor who has a minimally acceptable product at the projected lowest price. If the

contractor proposes a conservative contract price, there is no room for changes without affecting the contractor's cost.

The Government and contractor often have worked against one another in implementing changes. The contractor has assumed that the PCO or auditor will not allow reimbursement for hours and costs the contractor feels were appropriate for the work. Meanwhile, the PCO and TM try to find ways for the contractor to implement a change at a fair and reasonable cost. Often additional funding must be requested from the PM, who does not understand why the program cost is increasing. The XYZ case illustrates how incorrect specifications can lead to poor relationships. The ABC case left some officials with a fear of awarding contracts on a fixed price basis and of awarding to small businesses. The following examples illustrate other problems that have occurred where relationships have been strained.

1. Paperwork and Audits

One of the primary complaints of contractors is that the Government requires volumes of paperwork for each product. The company must open its books to inspection by Government auditors, who look for what is wrong. Under one contract modification, the assigned auditor disallowed the contractor's time sheets for a claim without thoroughly researching the contractor's submitted paperwork. The large discrepancy between audit findings and the contractor's proposal took

several months for the PCO to negotiate. At the end of the negotiations, both the PCO and contractor were disappointed with the audit report that was submitted. In fact, the PCO stated that the audit report was worthless and could not be used [Ref. 25].

2. Poor Communication

A fuze contractor incorrectly took direction from Program Managers in Washington, engineers, and even other contractors. As a result, several constructive changes were made to the contract, and there were schedule delays and product changes. The fuze contractor claimed to be doing his job by implementing changes as requested. The PCO was extremely frustrated by the contractor "end running" PCO authority in implementing changes [Ref. 26].

3. Poor Workmanship

Under a fuze contract awarded to a small business, using price competition, the contractor lost some of his skilled labor force. When the contractor's product failed lot acceptance testing, the Government discovered poor workmanship in sub-assemblies. After consideration, the contract was modified to extend the delivery schedule. When the contractor missed the second delivery schedule, a "show-cause" letter was issued by the PCO. The contract contained an ambiguous clause on lot acceptance testing. The PCO then made a determination to accept the units in an "as-is" condition, while the

contractor agreed to a price reduction in the contract. The components were shipped to another contractor for completion under a separate contract [Ref. 27].

4. Design Changes Versus Type of Contract

On one Fixed Price Incentive contract for development of a fuze, over 43 modifications were issued. This resulted in increased costs of $1.3 million on a base cost of $1,521,610 and a ceiling price of $2,468,000. The design of the item developed under this contract was not mature, resulting in developmental changes and the increased cost in the contract [Ref.27].

5. Limited Fuze Industrial Base

When the Desert Storm missions started in 1991, there was an urgent requirement for fuzes and missiles. The awarding of letter contracts for fuze components and support was deemed critical to the war. For one contract, there were two qualified sources for fuze model 123 and only one source for fuze model 234. Desert Storm was over before the delivery of any fuzes, thus avoiding a real test of the fuze industrial base rapid-response ability [Ref. 26].

V. SURVEY DATA AND RESULTS

A. INTRODUCTION

As noted in Chapter I, the goal of this study is to identify and overcome problems that are resulting in the exodus of firms from the fuze industrial base. Possible problems initially were identified through a literature search and interviews with numerous individuals who are affiliated with Government contracting and the fuze industry. Following this preliminary process, experts in the field were surveyed to validate these results, to document the problems in more detail, and to seek solutions. This chapter describes the survey and how it was conducted, and provides the results that were obtained.

1. Survey Form

A 15-question survey form was developed (see Appendix C), based on the problems identified and discussed in Chapters I through IV. The survey was intended as a means to obtain data on fuze acquisition programs and problems from the fuzing community. So that the responses would not be artificially limited, the questions were opened ended, and respondents were allowed to provide more than one answer to a question.

For all respondents, the 15 questions were divided into six categories: (1) the fuze industrial base itself, (2)

SOWs, specifications, military standards, and drawings, (3) the contract award process, (4) contract performance, (5) relationships between Government and contractor personnel, and (6) suggestions for improvements in the military acquisition process. The questions varied slightly depending on whether the intended respondents were Government or contractor personnel, but the meanings remained essentially constant for all participants.

2. Survey Respondents

A total of 130 survey forms were distributed by mail to four groups, as shown in Table I. The four groups are (1) contractors, (2) Defense Contract Management Command (DCMC) personnel, (3) Program Managers at NAVAIR and NAVSEA, and (4) NAWCWPNS personnel involved in the fuze contracting process. Of those distributed, 61 were completed and returned, for a response rate of 47 percent (see Table I).

TABLE I. SURVEY FORM DISTRIBUTION AND RESPONSES

Agency	Positions	Quantity Distributed	Quantity Returned	Percent Response	Percent of Total
Contractors	Contract Managers Program Managers	40	16	40	26
DCMC	Contracting Officers Quality Assurance	12	3	25	5
NAVAIR NAVSEA	Fuze and Missile Program Managers	17	7	41	11
NAWCWPNS	Contracting Officials	19	13	68	21
	Small Business Office	1	1	100	2
	Legal Counsel	1	1	100	2
	Technical Managers	40	20	50	33
Totals		130	61		100

Participants were asked to provide information on their position, years of experience, the programs on which they had worked, and related topics.

a. Respondents' Experience Levels

Respondents were asked how many years they had been involved in fuze acquisitions. The mean level of experience was approximately 18.7 years, with a median of 18.5 years. Contractors made up the most experienced group, with a mean of 32.5 years; the least experienced respondents were NAWCWPNS acquisition personnel, with a mean of 11.5 years. Program managers averaged 15 years of experience, DCMC average was 17 years, and NAWCWPNS Technical Managers averaged approximately 20 years in fuze acquisitions. The range in experience was from 2.5 years to over 54 years.

b. Business Size

The survey queried each contractor to determine the size of the business with which he or she was affiliated. Three reported that their firms qualify as small businesses. The remainder were associated with large business firms.

c. Missile and Fuze Programs

Respondents were asked to identify the missile and fuze programs with which they have worked. Responses are provided in Table II. A total of 18 air- and sea-launched

missile programs and eight fuze programs were noted by the survey participants.

TABLE II. MISSILE AND FUZE PROGRAMS

MISSILE PROGRAMS	FUZE PROGRAMS
AAAM	ESAD
ABF	FMU-139A/B
AIWS	FMU-140
AMRAAM	FSU-10
Bigeye	FZU-39/B
HARM	MK 24, MOD 3
JDAM	MK 54
Maverick	MK 89
Penguin	
Phoenix	
RAM	
Shrike	
Sidearm	
Sidewinder	
Sparrow	
Standard Missile	
Tacit Rainbow	
Tomahawk Cruise Missile	

3. Presentation of Survey Results

As noted above, the 15 questions on the survey form were divided into six groups. Survey participants' responses to these questions are provided in the following sections, which are organized according to those six groups of questions. The same format is used throughout Sections B through G. First the question itself is given, followed by a summary of the responses to the question. Then typical comments made by the respondents are provided, grouped according to the four participant groups listed in Table I. In most cases, the comments are quoted exactly. Others represent the combined responses of two or more participants, when comments are similar. Section H provides a summary of

the responses, and ties together the results obtained from the fuze experts who participated in the survey.

B. INDUSTRIAL BASE

1. Industrial Base Shrinkage

What do you feel is causing the DoD fuze industrial base shrinkage?

Approximately 50 percent of the respondents answered that the DoD industrial base decrease is a result of the changing world environment caused by the perceived end to the cold war, along with decreased defense programs and defense dollars. Other factors affecting the industrial base reported by the respondents are (1) the disparity between small and large business competition in fuze contracts (21 percent), (2) the increase in complexity of fuze technology, resulting in contractors leaving DoD related businesses (13 percent), and (3) profits regulated by the FAR, and awards to low bidders (6 percent). Summarized below are typical responses from each of the four groups regarding the effect on the fuze industrial base of the end to the cold war and decreasing defense budgets.

a. Contractor Comments

- Reduced fuze requirements in DoD budget as well as internationally.
- Peace; there is no perceived need for fuzes.
- Declining military budgets as a result of peace.

b. DCMC Comments

- The easing of the cold war and the shrinking DoD budget.

c. Program Manager Comments

- Defense cutbacks -- only major players can afford to carry the expertise and expenditures.

d. NAWCWPNS Comments

- Drawdown of research and development/production funds.
- Reduction of funding by Congress.
- Economics. Not as many fuzes being produced causing companies to fold.

2. Contractors' Pursuit of Future DoD Business

In the future, will your company be pursuing more or less DoD business and why?

This question was asked only of contractors. With the declining defense budget it was expected that some contractors would be seeking ways to move into the commercial marketplace, since the Government is the only purchaser of missile fuzes. The results from this survey validate that expectation, although not to the extent anticipated. Most of the responding contractors plan on pursuing the same amount of DoD business or more. The contractors' comments are paraphrased below.

- As a leader in fuzing systems, the company will continue selectively to pursue "core" programs where the firm clearly has a dominant market position and maintains a technological support base, or can realize an acceptable return on investment. On the whole, however, DoD business as a percentage of overall business will decline, placing greater dependence on commercial alternatives.

- We are trying to maintain our business base. Current budget cuts have resulted in a 20 percent decrease in our DoD-related sales.

- The same amount. DoD is our only business and we plan to survive any cutbacks by being a reputable, quality, cost-effective supplier.

- Our pursuit of DoD business will remain the same or may slightly increase. Although we are urgently attempting to diversify into non-DoD business, our survival still depends on supplying ordnance products to DoD. We are a "full service" fuzing company and well established in the community. We possess a "niche-like" technology and "know-how" that is not readily transferable to commercial markets.

- More. We want to expand the number of weapon systems, types, and applications. It is our area of expertise.

3. Government Incentives and Programs

To assure the delivery of reliable fuzes, what incentives or programs should the Government offer to encourage contractors to propose on future contracts?

The two most prevalent suggestions for incentives were multi-year contracts or development of long-term relationships (39 percent), and higher pay for quality performance (18 percent). The participants also preferred performance specifications over "build to print" specifications (14 percent) and contract awards based on *best value* instead of low-bidder method of contracting (7 percent).

a. Contractor Comments

(1) Multi-Year Contracts and Long Term Commitments

- Establish sole source, multi-year requirements to facilitate long range investment and resource planning.
- Develop partnerships with fuze suppliers who perform [provide quality fuzes on time] and assure long-term programs.
- The Government should *not* broaden its supplier base but rather *maintain* a smaller number of best-in-class suppliers. The Government's critical suppliers will have a viable business base and will deliver quality products in order to stay in the supplier base.

(2) Higher Profit/Pay for Performance

- Contract for items on a performance basis versus specification base. Give/provide a contractor incentives ($) for products that exceed the contract performance objectives.
- Consider scaling allowable profits and award fees on the performance and quality of the product instead of cost/schedule compliance.

b. DCMC Comments

(1) Multi-Year Contracts and Long-Term Commitments

- Use follow-on contracts without competition.
- Implement multi-year contracts for specific [firm] quantities.
- Target key technologies and award in accordance with keeping our industrial base active/strong. This would focus in on a smaller number of key suppliers. Industry is going this route; can the Government afford not to participate in this trend?

(2) Higher Profit/Pay for Performance

- Recommend that for contractors that meet, then exceed specific process performance levels an increased "value added" incentive should be included in the contract, provided delivery schedules are met.

c. Program Manager Comments

(1) Multi-Year Contracts and Long Term Commitments

- Long production runs will result in higher return on investment.
- Use multi-year contracts to allow cost-effective production runs.

(2) Higher Profit/Pay for Performance

- Allow industry to propose reliability design improvements and share the cost of demonstrating those improvements.
- Government should not be in the business of having to provide incentives for the contractor to deliver a reliable product. Total Quality Management is the name of the game.

d. NAWCWPNS Comments

(1) Multi-Year Contracts and Long Term Commitments

- Government and prime contractors need to enter into long-term commitments with fuze contractors who demonstrate capability to build quality into their product, rather than have it inspected in by the end user.
- If it's true that fuze devices for various programs have lots of commonality, then we ought to be doing fewer but bigger and better coordinated contracts to offer incentives to quality contractors to play.
- Recommend that the Government procure two or three years of fuzes at one time. This would result in lower cost

because of increased quantities. Many private companies such as electric component manufacturers make large runs of parts every one to two years.

- Best incentives the Government can offer are to increase the proposed production quantities. Currently, the companies with the greatest engineering ability to produce newer, high-tech fuzes are not interested because the low production quantities don't make it profitable for them to invest in fuzing. Increase the quantities.

(2) Higher Profit/Pay for Performance

- Contractors should be provided Total Quality Management (TQM) training, and incentives tied to contractors actively adopting TQM.

- Try incentive-type contracts with dollars and schedule incentives.

- Incentives such as awards for successfully passing lot acceptance testing would improve small business in providing good hardware.

- Award fee based on timely delivery and lot acceptance testing results.

- Money--contractors are beating down the doors to get whatever contracts they can. If it is becoming a buyer's market and awards are based on going to companies with proven quality, we will be ok.

- Incentives. Contractors should be given incentives for positive performance on a real time basis, e.g., award fees. Currently contractors are rewarded for poor performance because Government buys hardware at Government expense.

C. STATEMENTS OF WORK/SPECIFICATIONS/STANDARDS/DRAWINGS

1. Problems with Government Documents

What are the primary problems affecting Statements of Work, Specifications, Drawings, and Standards that you find most prohibitive?

DoD statements of work and specifications have been described as ambiguous in the national studies discussed in Chapter IV, and are listed as one of the primary problems in doing work for the Government. The respondents generally indicated that ambiguous DoD documents have resulted in contractual problems (31 percent). Summarized below are concerns and issues related to ambiguity in Government documents.

a. Contractor Comments

- Some statements of work are not written clearly enough to allow the extent of the tasks to be discerned. This causes risk which can lead to higher cost estimates or failure after award. Any exceptions from previous contracts should be disclosed.
- Statements of work and associated piece parts, prints, and specifications are usually at odds with the stated or required performance requirements.
- "To be determined" phrases in development programs, without the discipline to remove them and readdress the impact, is one of the problems with Government documents.

b. DCMC Comments

- Ambiguity, misinterpretation, conflicting interpretation, wrong revision or level of drawings, unrealistic specifications and standards.

c. Program Manager Comments

- Sometimes, even we [Government] don't know what we are asking for. Most often, we clear up these ambiguities along the way. This method of operation by default has become a way of life in the Government.

d. NAWCWPNS Comments

- There appears to be ambiguities in specs. Drawings on contracts I have been involved with have been Level II and moving to Level III without necessary testing done to prove out design and/or design changes.
- Terms are too vague--the instant people understand what is required, they move around, priorities change, sponsors go away, corporate history is lost.
- We [Government] don't know how to describe what we want and industry does not know how to interpret.
- The primary problem with statements of work or technical documentation is interpretation of requirements. Avoiding ambiguity in requirements is a difficult problem to overcome.
- Primary problem is that people do not read or research the statements of work or specifications. They copy what was in an old or similar statement of work. Give the contractor more latitude. Tell him what you need in the SOW, the specifications, drawings, and standards. Limit the options and you stifle new thought.

2. Government Specification Flexibility

Do Government specifications allow flexibility in the design and production of fuzes? If not, please suggest what changes should be made in this area?

The majority response to this question was that the Government should allow more flexibility in specifications. Approximately 65 percent of the participants asserted that improvements in the design could be achieved by allowing more contractor input. The amount of flexibility would have to be determined by the program office, and depend on safety and reliability requirements. Less than 20 percent stated that the Government should maintain control of the specifications

and drawings. Responses of the majority who favored flexibility are summarized first, followed by dissenting opinions when these are made.

a. Contractor Comments

All contractor comments indicated their desire for more flexibility in specifications. There were no dissenting opinions.

- Identify the performance requirements of the fuze, establish a vigorous acceptance test procedure, e.g., live fire, functioning, etc., and buy off a performance test.
- Yes, again sensitivity to commercial standards and alternatives based on form, fit, and function would provide flexibility and continued commitment of resources.
- Provide more black box specifications and permit the contractor to have the freedom to develop a compliant end item.
- Virtually no flexibility is allowed. The specifications should cover the input, output requirements and physical characteristics in realistic terms. Then give the contractor the flexibility to design the product within those limits. Don't over-spec a product to where the costs are prohibitive.

b. DCMC Comments

(1) Comments Favoring Flexibility

- Yes, but very clearly defined limits should be set forth. Contractors in the fuze business, for the most part, employ very competent personnel who have some positive ideas on how to improve on the design and production of fuzes.

(2) Dissenting Comments

- Not in design. As the end user of weapons and munitions, [the Government] has the ultimate responsibility for specifications. Fuze functioning needs to meet intended design needs and unless contractors test and fire to same levels as the test and design activity, I'd keep it the same. However, production flexibility, when it does not affect safety, should be encouraged.

c. Program Manager Comments

(1) Comments Favoring Flexibility

- Absolutely; we are in the dark ages with both design approaches and production methods.
- Yes, to avoid redesigning for producibility.
- Of course; they [Contractors] are the experts, why tie their hands with rigid requirements. We must however be cognizant of the effects of these changes on our baseline design and environment.

(2) Dissenting Comments

- The Government does allow flexibility in the production of the items sought. It is not the Government's position to tell the contractor how to do his business. The Government specifies the requirements and the acceptance testing related to those requirements. It is the contractor's responsibility to produce, once the design is frozen.

d. NAWCWPNS Comments

(1) Comments Favoring Flexibility

- I think there needs to be something to make contractors accept more responsibility and ownership, and maybe design flexibility gets them that.

- The requirements should be more performance and interface specifications. The system should be based on the Government saying what they expect and having a communications loop to provide feedback on how well the contractor is meeting expectations. Currently the risk of how good the technical package is for use in production is with the Government. The risk has to be moved to the contractor.

- The Government should work with the contractor to develop the documentation. The Air Force concept of Mil Prime contracting does this effectively. There should be some flexibility but once the design has been qualified the major emphasis should be on flexibility.

- Yes. In most cases we are specifying and the contractor is building the same fuze as we were doing 20 to 25 years ago. Things have been rearranged but basically it is the same fuze in most NAWCWPNS-designed fuzes. We need to allow the fuze contractors to take advantage of the technology that has been developed during the last quarter of a century.

- In the design phase, specs should state requirements and allow flexibility as to the method to meet those requirements. This gives maximum use of contractor initiative. During production, flexibility should be reduced to only that which can be controlled by the ECP [Engineering Change Proposal] process. This will ensure maintenance of performance for all items produced.

- Flexibility in the development phase is good as long as the contractor is making use of the technical expertise in the Government laboratories and not trying to do something that is known not to work. However, because fuzes are safety devices, their manufacture needs to be carefully controlled.

(2) Dissenting Comments

- No, that's why we write contracts. Let the contract be the vehicle for exceptions.

- The Government should have total control of the design. The contractor should produce using the best industry and technical practices with close Government participation.

- No, the Government should always be responsible for the design to ensure system-level performance. Past history has shown that it is risky to buy black boxes from contractors. Then we lose *all* insight into and traceability of fuze production.

D. CONTRACT AWARD PROCESS

1. Types of Contracts

What type of contract award processes have been used in the awarding of fuze contracts?

The Government bidding process has been identified as a problem in conducting business with DoD, according to the studies reported in Chapter IV. The survey respondents provided a list of contract types that have been used for fuzes which included FFP, FPI, CPFF, CPIF. The respondents indicated that most contract types had been used in their careers but the most reported experience was with fixed price type contracts and awards to the low offeror (75 percent). Under question two the respondents provided more detailed opinions on their level of satisfaction with fixed price-low offeror contracts.

2. Benefits and Drawbacks of Contract Award Processes

What were the benefits or drawbacks to the award process?

The majority of participants in this study expressed grave concerns over Government reliance on using price as the primary award factor in contracts, especially in development fixed price contracts. The most common theme was that the DoD

should use the correct contract type for the work to be accomplished.

a. Contractor Comments

- Too much reliance on going only to the low bidder regardless of that contractor's performance or technical ability. Limited technical knowledge of the item being purchased by contracting personnel.

- Historically, fuzing contracts have been awarded to the low offeror. Many of these companies do not have the engineering wherewithal to support production. The proposal/selection process takes too long. Restrict free competition to proven producers. Select on best value.

- Sometimes the worst thing that can happen to you is to win! If you take exception to poor specifications and drawings during the bid cycle, you will be declared noncompliant and thrown out. What happens is you usually keep your mouth shut and work it out the best way you can.

- Full and open competition usually ends up being a price competition and does not result in long term quality at a fair price and on-time delivery. These factors in the long term result in the lowest overall cost to the Government. Best value should result in overall best product for the dollar. However, it seems that all the regulations and legal issues make this the most difficult one to implement.

b. DCMC Comments

- Usually pricing has been the key factor, or so it seems from our perspective.

- I personally think it is counter-productive to key award decisions largely on price. The recent [X] missile replenishment contract was delayed pending bidders' protests and the price of the low bidder is so low that it appears to me there may be problems in performance as a result.

c. Program Manager Comments

None of the Program Managers provided comments on this question. Their contractual problems and improvement suggestions were provided under the next question.

d. NAWCWPNS Comments

- I have used FFP, low offer [contracts], but the drawings were not firm. There needed to be design testing done. Not enough money, so that when testing was omitted it created horrendous problems downstream.

- Fixed price research and development [awards] are a disaster, as are low rate production, fixed price. Too many changes, neither party has flexibility. CPFF are better; more flexibility, but a greater chance of overruns and sloppy cost contract. Cost-plus-incentive is probably the best but the administrative workload is tremendous and so many contract amounts do not justify the extra administrative burden.

- In my area, "low offerer" seems to be the only criterion for awarding fuze contracts. The primary drawback is that, if a contractor is qualified, it is difficult for other contractors to complete on a cost basis. Therefore, even if a contract is having current problems, the company will still be able to low bid the contract. The Government should actively require contractors to re-qualify if the company is having major technical production problems.

- FFP [awards] to low technically-acceptable offeror have been used for some development [contracts] and for most production contracts. Most contracts are open competition. There is an inability to select the perceived best offeror due to bid being too high. No incentives to excel. Fixed price contracting does not allow for flexibility nor encourage contractors to experiment with improvements.

- Past fuze experience does not mean much when there is a small number of companies producing fuzes. The ones that are producing do not have a positive rapport with the Government. This does, however, make awarding the contact to an already qualified contractor less expensive. But awarding to a qualified non-producer rather than a

non-qualified production company will cost more over the life cycle of the fuze. With the design submitted at RFP, this gives the contractor 30-60 days to design the perfect fuze. This does not work. We must then evaluate a contractor on how fast they can create paperwork, not their capability of design.

- Fixed price is good for production where few uncertainties exist, but poor for development. As a matter of fact, fixed price contracts are inconsistent with the reason for doing developments, i.e., we do development because we do not know what the integration problems are.

- Fixed price does allow for good cost control if there are no changes to design or effort. It does not allow communications between technical people. No flexibility if major problems are found. I would like to try CPAF.

3. Improvements to the Procurement Process

How can the Naval Air Warfare Center Weapons Division, China Lake, California, improve the procurement award process?

The responses to this question do not suggest a predominant area for improvement. However, the *best value* acquisition process (25 percent) and establishment of a partnership long-term customer/supplier relationship (16 percent) were proposed by participants. Provided below are summarized comments in these two areas, followed by a brief synopsis of miscellaneous suggestions.

a. Contractor Comments

- Give more consideration to the type of work to be performed and the most appropriate contract type for that effort.

- Restrict free competition to proven producers. Select on *best value*.

- Work in partnership with a few critical suppliers.

b. DCMC Comments

- Because this is a highly specialized area with a limited application and a shrinking market, I believe we should be identifying key industrial base producers and awarding to service our National Defense interests. Price should not be the critical factor, [although] it always seems to be.

- Develop longer-running contracts, support the quality vendors, and do not award to poor performers on a low cost basis only.

c. Program Manager Comments

- Place more emphasis on improving training in the acquisition process, use prime missile contractors to acquire fuzes rather than supplying GFP fuzes to prime missile contractors, and carry out better pre-award surveys.

d. NAWCWPNS Comments

- Do more *best value* [contracting]. Combine different program requirements to make it worth a contractor's time to compete.

- Develop more skill in developing and using *best value* criteria.

- Award contracts based on past performance, not solely on cost. Initiate multi-year procurement.

- Allow previous performance histories to influence the contractor choice. Do not require that the lowest offeror within the competitive range be selected.

- Establish a limited list of qualified industrial sources and be sure to award them a steady amount of business each year so they can build a competent engineering staff and maintain a stable, continuous production line and stable workforce. They can do TQM.

e. Miscellaneous Suggestions for Acquisition Improvements

- Cut the red tape. Throw out the low bidder philosophy. Streamline the proposal evaluation process [fewer people]. Put the needs of the program first.
- Keep an open mind! Take advantage of contractor expertise. Be willing to accept that there may be other ways to do things than the China Lake way.
- Start by ensuring that the Government design is robust and producible.
- Start over. Throw out the books. Require less paperwork.
- Streamline the number of approval/authorization levels and required time for responses.
- Shorten the time for initial award negotiations and shorten the time for contract modifications.
- Train the evaluators, engineers, and pre-award teams.

E. CONTRACT PERFORMANCE

1. Fuze Contract Performance Difficulties

In your opinion, what are the major difficulties associated with performance of fuze contracts?

The primary difficulties mentioned by respondents were problems with the specifications and design (21 percent), problems with either the Government delivery schedule or the contractor's late delivery (22 percent), quality of the product (15 percent), lack of teamwork and cooperation between the Government and contractors (10 percent), and the procurement process itself (10 percent). With regard to delivery schedule problems, it is interesting to note that

most contractors felt that the Government used unrealistic schedules, while the Government complained of late contractor deliveries. Difficulties related to the top three categories (specifications, schedule, and quality) are summarized below.

a. Contractor Comments

- When the contract is not well defined, e.g., to-be-determined (TBD) requirements in a specification, or the contract is subject to a lot of interpretation.
- Unrealistic development schedules are major difficulties.
- Little time to develop or consider alternative designs but time made to fix.
- False schedules drive programs. Contracts driven by dollars rather than technical goals.

b. DCMC Comments

- Engineering Change Proposals, waivers, deviations, and other change papers hamper performance.

c. Program Manager Comments

- Schedule slips.
- Meeting schedule delivery dates; this may result from the inability to do parallel subsystem design and developmental efforts to prevent system integration problems.

d. NAWCWPNS Comments

- Timely delivery and conformance to the drawings.
- Poor design by the Government, lack of up-front engineering by the contractor to identify potential problems.

- Costly non-working fuzes (non-conformance to specs), accidents, poor delivery schedule, failure to pass inspection, and many changes requested by the contractor.

- Major problem is schedule slip because the contractor has no incentive.

- The major problem currently is the inability of companies to build a quality product. This is because the design is not optimized for producibility and/or because companies do not have production processes that build quality in rather than waiting for the testing to weed out the bad items.

- The contractor not following all the requirements laid upon him and then being written up. Then having to respond to inspection reports. Then having to respond to the rebuttal of their response. We [the Government] also have inadequate data packages and expect the contractor to make it like it should be.

2. Performance Difficulties Caused by Pre-Award Actions

What difficulties in the performance can be attributed to the pre-award actions by the Government and/or contractor?

Approximately 36 percent of the respondents stated that the problems began with statements of work and specifications, while 23 percent identified the source selection process as one of the problems in achieving satisfactory performance. Provided below are paraphrased comments related to these two categories of difficulties.

a. Contractor Comments

- No defined areas of work on FFP contracts or known problems with the technical data package. Also the "not-invented-here" mind set by China Lake.

- Failure to disclose past performance problems.

- The Government often has a mind set concerning the design. Most advanced developments are done in Government laboratories and an understandable "not-invented-here" factor usually accompanies the baseline design.

- Evaluation factors should be thoroughly thought through to ensure picking the most competent contractor who can perform and deliver a product at the lowest overall cost to the Government.

b. DCMC Comments

- Engineering Change Proposals cause difficulty.

c. Program Manager Comments

- Design baseline is not frozen by the Government before being given to industry. Sound production and manufacturing processes are not used by industry.

- Poor selection criteria in the evaluation process.

- Sometimes the Government does not have a good investigative team possessing adequate historical data [about] a company. Thus, the Government is likely to make poor judgments concerning the capabilities of a contractor to fulfill all or parts of the contract requirements.

d. NAWCWPNS Comments

- The contractor has no plan to analyze and fix the data package.

- Not enough preparation of specs, drawings, etc. Not getting documented agreement on what is required on each side.

- Many performance difficulties can be attributed to preliminary plans or specifications exchanged in the pre-award period. After award, when the plans and specifications are finalized, they often contain substantial differences between their preliminary and finalized form. The Government usually expects the contractor to perform to the final version but the

contractor will usually only be willing to perform to the preliminary version unless they are awarded "consideration."

- Sometimes the Government is too rigid in its specifications and will not allow contractor inputs to be heard.
- Inability to go to other than the low cost offer.
- Government stresses low cost, not *best value*.
- Improper source selection criteria. Not enough pre-award communication between all parties. Over-zealous contracting officers that milk every possible cent out of the contract price till there is not enough left to do the job right.
- Wrong people performing pre-award surveys.

3. Resolving Contract Performance Difficulties

What have you done to resolve contract difficulties? For example, did you submit claims, engineering change proposals (ECPs), or request changes to the contract?

The contractors who responded to this question stated that submitting changes would cause a more adversarial relationship to ensue. The Government response to this question was that the contractor requires more time or money for changes. The allowance for an equitable adjustment to the contract was not recognized by either the contractor or Government as an "acceptable" practice. Also specified was the lack of pre-award communications between the Government and the contractor, and among NAWCWPNS, Program Managers, and DCMC offices. Typical responses to this question are paraphrased below.

a. Contractor Comments

- We have used ECPs, changes to contracts, and claims. But the filing of a claim was only used after all other avenues were explored.
- Sometimes we suggest changes but usually at great risk/peril to future contracts. Contracting officers do not like to have their authority challenged via claims, ECPs, etc. It is a rare command that willingly accepts changes.
- In some cases we submit changes, but that can lead to bad customer relationships.
- We usually try not to submit claims for technical data package deficiencies in production programs. If we were the developer, we feel responsible for the data package. In other situations, as in "build to print" contracts, we try to work out the problems via mutually agreed ECPs.

b. DCMC Comments

- We strive to do the best pre-award we can.

c. Program Manager Comments

- Thorough design quality by Government. Thorough technical review of potential offerors. Clean and well-understood specifications and drawing packages by a full-time, permanent Government engineering staff.
- Action must be initiated outside the process. Once you are underway, its like paddling upstream; you just go with the flow.
- In my case, we have identified the history of lot acceptance testing failure rates and briefed industry on lessons learned. Also industry will design future fuzes, not the Government.

d. NAWCWPNS Comments

- Numerous ECPs were issued. Contractor filed a large claim.

- Changes were done but it was too late to avoid very costly disagreements. One of the biggest problems is having too many people at too many sites involved...the Washington sponsor has to look at things which may take literally months, then China Lake has to look at them which may take more months, the procurement folks do their thing, more months, then after all this, it may be dropped or the funds may not be forthcoming. These problems could be lessened with more cooperation among all the players.

- With the lack of fuze producers, termination is almost impossible because there is nowhere else to go (no other source). Consequently, the Government develops "tiger teams" to go help the contractor get back on track.

- My experience in resolving difficulties has been to change the requirements, if technically acceptable, or pay the contractor more money if not technically acceptable.

- Few changes because our sponsor controls our actions and they work to a different agenda.

- All types of changes have been undertaken at one time. However, attempting to fix the problems after the contract award is not very satisfying or efficient.

- Mostly issued contract modifications to make schedule changes, sometimes getting small consideration in return. A couple of times issued a termination for default, although this can be very time consuming if litigation results.

- After contract award then it is ECP time, time to change the drawings or specification even though this should have been done prior to contract award. The thing you really do not want to do is issue a termination notice.

Some responses suggest that better communication might be the key to resolution of Government and contractor performance difficulties:

- The Government personnel must get in and work with the contractor to resolve these problems. We need to pull down our barriers and quick-pointing fingers and get on with giving the fleet what is needed.

- Sometimes the contractors have submitted options or alternatives at the Government's request, which allows some flexibility on both sides to get a performing product at a reasonable cost and schedule.

- My current attempt to resolve difficulties is to educate people (Government and industry) about the problem. Resolution will be the result of both Government and industry working together to fix the problems. I think each is incapable of fixing the problems on their own.

4. GFP Fuzes Provided to Prime Missile Contractors

Are fuzes provided as Government Furnished Property or "Make or Buy" under your contract? What problems have you experienced in this area?

This auxiliary question was addressed to prime missile contractors and to subcontractors who provide fuzes for prime contractors. The purpose of this question was to determine if GFP fuzes result in work disruption and missile program delays. The following responses were received.

a. Prime Missile Contractor Comments

- We were forced to request relief from delivering fuzes with missiles, and provided consideration to the Government for our missile contracts. We had serious concerns with this due to the fact it has always been our position that there was only one qualified supplier, and the Government played a part in the supplier delivery problems. The Government currently is qualifying the only known supplier of these fuzes, even though we have two production contracts to deliver compete missiles. This a very awkward situation for us, since the baseline is being determined by the Government with a Government-selected source even though we eventually will have to supply fuzes provided from that source. It is highly inappropriate to

think we could afford to qualify another supplier or that the Government would pay to support the qualification of another source. We might be willing to accept a contract to design and build an electronic safe and arming device but not a mechanical fuze. We are currently working closely with Government agencies including NAWCWPNS on the design of an electronic safe and arming device for fuzes.

- As a prime missile contractor, we did not possess the mechanical fuze technology to produce the fuze in house. The fuze had been subcontracted to previously-qualified mechanical fuze contractors. When our company experienced delays in delivery and reliability problems with the mechanical subcontracted fuzes, we worked in conjunction with NAWCWPNS to qualify an electrical fuze for our missile.

- Our issues have been the same whether the fuzes were GFP or made in house. There were costly DoD specifications and standards. Time variations in development and production cycle of individual fuzing components preclude the most efficient approach to overall systems designs, i.e., S-A systems, fuze contact devices, and proximity sensors are based on non-current technologies.

b. Fuze Subcontractor Comments

- Your concern should be to maintain a viable fuzing base. Prime contractors are developing their own fuzing groups and ignoring the established community. However, fuzing then becomes a very small portion of their business mix and is readily abandoned if not profitable by their standards. This is risky for the Government and could seriously impair the surge and mobilization base you now have.

F. BUSINESS RELATIONSHIPS

1. Adversarial and Weak Interrelationships

In your opinion, are there any weak (e.g., lack of training/knowledge) or adversarial relationships in your dealings with the Government?

Over 50 percent of the responses described weak or adversarial relationships, while 20 percent were extremely

satisfied with their business relationships. Both the adversarial and positive business relationships are represented in the comments below.

a. Contractor Comments

(1) Adversarial Comments

- Dealing with the Government at all levels has become more and more an adversarial relationship. This is not Service related, but spans all Services. The fraud and deceit by a few, especially primes, have taken their toll on smaller companies. Auditing is a nightmare. Negotiation positions are unrealistic.

- There seems to be a general feeling by some people in Government that they should treat contractors in an adversarial manner, e.g., get the most out of the contractor even if it kills him. The way to get the job done is both parties have to work as partners. The Government should get a quality product at a fair price and the contractor should make a reasonable profit.

- Getting better, but still adversarial with Defense Contract Administration Services, make-work audits. Customer program, contractual, and audit personnel work independently--goals are not the same, creates both technical and financial problems.

(2) Positive Comments

- No. The relationship with the Government has been very good. The Government and contractors need to continuously improve those relationships.

b. DCMC Comments

(1) Adversarial Comments

- Lack of knowledge on criticality of fuze functions and safe separation distance requirements causes problem in decisions.

- Lack of communication, especially with the technical activities.

(2) Positive Comments

None were provided in this category by DCMC respondents.

c. Program Manager Comments

(1) Adversarial Comments

- General lack of understanding of each other's role and responsibility throughout the process.
- Yes, enough said; I could write a book.
- Other organizations tend to operate differently to some degree and also have different priorities which tend to sometimes frustrate those of us trying to meet certain deadlines.

(2) Positive Comments

- In my program, No. Government team is of one mind. Contractor very sensitive to any issue, due to cost and schedule impacts and difficulty getting up to speed.

d. NAWCWPNS Comments

(1) Adversarial Comments

- Yes!!! Contractors blame the Government, the Government blames the contractors. It is probably equally both's fault. I have heard tons of complaints from ACOs, QARs, engineers, sponsors about: they are late, they don't comply, they want waivers, ECPs, they want more money to fix problems they either caused or should have been smart enough to prevent; the little fuze is holding up a huge missile program. Primes say the same thing. Mostly, I have heard fuze contractors complain about us not being fair to them, and it's unreasonable to meet our schedules within budget and be compliant. There is a huge lack of trust with certain companies and employees.

- Sponsor contributed to this problem. Long-standing relationships with contractor also clouded issues.

- There often seems to be unrealistic goals set by the sponsors. However, when we are faced with a totally disastrous contract or program, there is usually enough blame to spread over everyone.

- Yes, there have been. Primarily this is a function of "rice bowls" and the contractors playing one off against the other.

- Adversarial relationships between Government agencies or with the contractors in areas of technology, management, contracts, documentation, etc., are not uncommon. Weak relationships exist, but they do not survive long because the weak elements are soon replaced or by-passed.

- Yes, many local DCMC functions assume an adversarial relationship with the contractor. Therefore conflicts arise and both parties lose sight of the major goals.

- Yes. First the basic nature of the contracts process itself creates an adversarial relationship. Talk with PCOs what they have to do to get past the contract review board. Also the ACOs and QARs are a problem; it appears they are worried about having their jobs taken away. Plus inadequate staffing resulting in time delays is a problem.

(2) Positive Comments

- Most of the relationships have been satisfactory, especially this past year. DCMC has redefined who their customer is and are providing better service.

- In most cases it has been very good.

- The technical community usually works well together.

2. Improvements to Interrelationships

What can be changed to encourage better relationships?

Analysis of the survey results revealed that 24 percent of the participants suggest that improving

communications would enhance relationships among those in the fuze community for both Government and contractor personnel. Establishing long-term relationships with suppliers and teamwork among members were solutions proposed by 23 percent of the participants. More than 50 percent of participating Program Managers reported that they are satisfied with the contract and technical support they receive from NAWCWPNS. A total of 11 percent of all respondents stated that they were happy with the status quo.

Other suggestions included better program support by upper and middle management in understanding the issues and empowering acquisition personnel, incorporation of a systems management process, trust of other agencies, and cross training. Quoted or paraphrased below are comments from respondents concerning (1) improved communications, (2) the Total Quality Management (TQM) philosophy and long-term relationship arrangements, and (3) positive comments on what is being done correctly to encourage good Government-contractor relationships.

a. Contractor Comments

(1) Communications

- More open communications with less emphasis on contractual impact.
- Improve communications to all parties involved.

(2) TQM and Long-Term Relationships

- TQM principles that are used in the commercial world between contractors and suppliers should be taught and used between the Government and its suppliers.
- Really foster partnerships in all disciplines, between primes and subcontractors.
- We should explore ways to work as a team to the mutual benefit of the Government and contractor, as well as the taxpayer.

(3) Positive Comments

None were provided in this category by the contractors who participated in this study.

b. DCMC Comments

(1) Communications

- More frequent visits by PCOs and managers to contractor facilities and to interface with contract management personnel.
- Anything that fosters improved communication and eliminates redundant administration effort will encourage better relationships.

(2) TQM and Long-Term Relationships

No comments were provided in this category by the DCMC survey participants.

(3) Positive Comments

None were provided in this category by the DCMC survey participants.

c. Program Manager Comments

(1) Communications

No comments were provided in this category by the Program Managers.

(2) TQM and Long-Term Relationships

None were provided in this category by the Program Managers.

(3) Positive Comments

- Upon my request for assistance, NAWCWPNS provided me with expeditious, excellent technical support and information.
- The work done by a PCO at China Lake on a recent fuze contract was excellent. Her persistence in holding the contractor to all necessary deliveries helped in getting the product on schedule and without additional charges the contractor wanted to impose.
- It is improving in the fuze arena, but we will need to continue the efforts for the next few years.
- My NAWCWPNS technical support is super; however, this is not the general case; we have grown our own expert team for our fuze.

d. NAWCWPNS Comments

(1) Communications

- Better communication from the beginning of the procurement with better planning and realistic planning.
- Better communication. Government and contractors need to be better suppliers and better customers. We need to understand our roles.
- Clarity and defined responsibilities.
- Frequent dialogue and face-to-face [discussions] to understand each other's problems.

- Visit the plant, talk with the Government plant representative, call them.

(2) TQM and Long-Term Relationships

- Demand TQM, customer/supplier awareness, process control.
- More thorough education for all those involved that procurement is a *team* effort.
- Establish long-term relationships.
- Our technical managers must become more in tune with sponsors' needs and work to support those needs. Build confidence in our ability. Be there when we are needed. Exceed their customer expectations.
- Make the PCO and ACO part of the acquisition team, along with the system sponsor and the laboratory engineering team.
- More team building.

(3) Positive Comments

- I can't answer because I have good relationships now.

G. FUZE ACQUISITION IMPROVEMENTS

This section of the questionnaire consisted of a single question.

> In your opinion, if you could improve or change any three areas in fuze contracting, what would they be and why?

The purpose of this question was to encourage respondents to synthesize the previous answers and to suggest changes and improvements to the DoD process of acquiring

fuzes. Suggested changes and improvements fell into five major categories, listed here in descending order, from highest to lowest response rates.

- Use of TQM and long-term relationships
- Implementation of *best value* source selection in fuze acquisition
- Use of performance specifications versus "build to print" and clean preparation of data packages
- Streamlining the acquisition process
- Providing monetary incentives to contractors for quality and prompt delivery

Comments related to these five areas are summarized below.

a. Contractor Comments

(1) TQM and Long-Term Relationships

- Via TQM, reduce paperwork and meetings. Increase effective technical [assistance] and support.
- Use TQM principles between the Government, contractor, and suppliers.
- Establish a long-term relationship with your top-performing contractors and work with them to ensure the highest quality and most economical products for the Government.

(2) Best Value Acquisition

- Increase emphasis on purchasing *best value*, not the lowest price. Industry is doing this and the Government should too.
- Emphasis on "true value" as selection criterion.

(3) Performance Specifications and Data Packages

- I would use "performance" contracting versus "build to print" and buy off hardware in real-world tests, e.g., actual test firings.

- More emphasis on commercial specifications and standards of reliability which may exceed DoD requirements, at a fraction of initial development, production, and logistics costs.

(4) Streamlined Acquisition Process

- Improve the cycle time required at every level of contracting from award to final payment of the contract, because time is still money.

(5) Financial Incentives in the Contract

- Realistic schedules and adequate financial rewards for performance.

b. DCMC Comments

(1) TQM and Long-Term Relationships

- DoD should be focusing on our smaller resources (funding and personnel), developing a much smaller circle of strong suppliers. With the TQM philosophy, we should strive for continual improvement and focus in on establishing and maintaining essential technology and capability in our vendor base.

(2) Best Value Acquisition

DCMC respondents did not provide comments.

(3) Performance Specifications and Data Packages

- Insure a clean technical data package

(4) Streamlined Acquisition Process

No comments were provided in this category by the DCMC respondents.

(5) Financial Incentives in the Contract

- Mandatory process performance index requirements in all contracts and reward ($) for contractors that surpass them. This would attain highest levels of reliable functioning and safety.

c. Program Manager Comments

(1) TQM and Long-Term Relationships

- Involve industry more heavily and formally in the development process.

(2) Best Value Acquisition

No comments were provided in this category by the Program Managers who participated in this study.

(3) Performance Specifications and Data Packages

- Make industry responsible for both the design and production, i.e., drawings and hardware.

(4) Streamlined Acquisition Process

- Streamline the proposal process; put the needs of the program first.

(5) Financial Incentives in the Contract

- Provide incentives for producibility

d. NAWCWPNS Comments

(1) TQM and Long-Term Relationships

- Establishment of long term relationships which should help on improving quality.
- Management philosophy with commitment to provide world class service and products. By doing so, the problems of quality, unreliable units, and late delivery would automatically be corrected.
- The Government needs to develop good, reliable contractors. This takes a stable environment with a partnership relation between Government and industry.
- Establish a stable fuze industrial base and keep a steady stream of development and production contracts flowing into those few, well-qualified sources to allow them to make a reasonable profit and allow them to invest in modern facilities and continuous training of their people and improvement of processes.
- Develop a greater (which we can do) working relationship with contractors. Present time we are somewhat recognized as the "auditors." Always finding wrongs. We need to work in the opposite direction, recognizing wrong, but praising right. Working in this type of atmosphere (TQM) produces, encourages, and directs productivity, and strengthens relationships.
- Allow Government and industry teaming prior to and during contracting.
- Procurement strategy, multi-year procurement for lower cost and higher reliability.

(2) Best Value Acquisition

- Use *best value* and different contract types.

- We really need to use different criteria for selecting contractors. Much more attention needs to be put on past performance and capability to produce a quality item and less on snazzy paper design for a particular project. Also, *best value* needs to be emphasized to precluded getting an unsuitable contractor on the basis of an apparent cheap price. A strong technical team needs to evaluate the proposal for reasonableness, and companies should be penalized for unrealistic cost and schedule promises. We need to emphasize capability in the selection criteria. We need to team with the company that will be producing the item fairly early in the development process to ensure concurrent engineering.

- Award contracts based on contractor's ability to produce, not on past fuze experience.

(3) Performance Specifications and Data Packages

- Involve the contractor in developing the specifications. They have a lot to contribute. Give the contractors more flexibility in the design and production of fuzes.

- Better defined specifications and drawings.

- Get industry's inputs to the contract, via industry briefs and question-and-answer sessions, before putting out the RFP.

(4) Streamlined Acquisition Process

- I would really like to see the time it takes a contract awarded substantially reduced.

- Simplified paperwork requirements. Contracts are very difficult to understand and are very lengthy.

- Accelerate the contract award process. Most programs are very schedule driven, and when trying to initiate new programs the long contract award time (even with urgency justifications) can be a negative selling feature.

- Simplify the procurement process to make it easier to do business.

(5) Financial Incentives in the Contract

- It would probably be better to reward whoever gets it right.
- Incentive fee contracts.
- Maybe a cost-sharing type of contract should be tried.
- Provide incentives for excellent performance. We will get better fuze suppliers and higher quality fuzes with on-time deliveries.

H. SUMMARY

Analysis of the survey data has revealed that contractors and Government personnel have coinciding perspectives, regarding the missile fuze industrial base and the fuze acquisition process. This section summarizes the data collected via the survey of fuze contract experts, in combination with applicable data from Chapters II through IV. Findings are organized into six categories.

- Decrease in the fuze industrial base
- Ambiguous specifications
- Contract award process
- Post-award fuze contract performance
- Contractor and Government relationships
- Improvements to the fuze acquisition process

These categories are based on the primary focus of the research (discussed in Chapter I) and on the collected survey

data. The summary will provide a solid background for conclusions, recommendations, and suggestions for improving the fuze industrial base and the fuze acquisition process.

1. Decrease In the Fuze Industrial Base

Both contractors and Government officials have stated that the paramount reasons for a decreasing industrial base for the military is the changing world environment due to the collapse of the Soviet Union. This changed environment has resulted in a reduction in the Defense budget for weapons and weapon components, including fuzes. While the quantity of fuze contractors has decreased, the Government requirements for new weapons and fuzes are also expected to decrease, with reduced military budgets. The willingness of fuze contractors to make proposals to meet future Government requirements may be contingent on the size of the acquisitions and on the profit margins that are allowed.

In the survey conducted for this study, 39 percent of the respondents stated that the Government should commit to long-term supplier and customer relationships and should use more multi-year contracts. The longer contract commitments would serve as an incentive to contractors to invest in fuze technology efforts. A subsidiary incentive mentioned by contractors and Government representatives was higher profits for quality fuze contract performance. Contractors noted that their companies were willing to continue specialized fuze

component work, although they expected fewer procurement dollars to be available. Fuze component work generally is not transferable to commercial efforts; therefore most contractors prefer to remain in the DoD fuze business, if at all feasible.

2. Ambiguous Specifications

The primary problem listed by survey respondents was ambiguous Government documents such as statements of work, specifications, military standards, and drawings. An overwhelming 65 percent of the contractors and Government participants indicated that contractors should be allowed more flexibility in fuze design. Overly-detailed Government documents restrict enhancements to fuze designs. If Government-supplied data are ambiguous or incorrect, both contractors and the Government programs for which they work experience delays and disruptions as evidenced by the XYZ case study in Chapter IV.

3. Contract Award Process

Contractor and Government respondents reported experience with a wide array of contract types, including Firm-Fixed-Price, Fixed-Price Incentive, Cost-Plus-Fixed-Fee, and Cost-Plus-Incentive-Fee; but the most common and troublesome contract type identified was Firm-Fixed-Price (FFP). As discussed in Chapter III, FFP contracts are used for well-defined requirement. The contractor is required to

deliver an end product for the "fixed price" awarded in the contract. The majority of survey respondents noted that they have had experience with fixed-price fuze development contracts which were troubled by claims, engineering changes, delays, and increased costs.

In addition, several participants noted that the procurement award process for FFP contracts is based on the *low acceptable offeror*. The *low acceptable offeror* was not deemed by contractors and Government respondents to be necessarily the *best value* in technical expertise and product quality. The problem resolution recommended by 25 percent of the participants was specifying an appropriate contract type, using *best value* criteria as explained in Chapter IV. The consensus concerning the acquisition award process was that FFP contracts should be used only when the design and product requirements are firm. An inappropriate contract type can cause delays and increased costs, often resulting in adversarial relationships between contractors and the Government.

4. Post-Award Fuze Contract Performance

Concerning contract performance, contractors claimed that the Government's delivery schedule for fuzes is unrealistic, while the Government countered that the contractors were frequently delinquent in delivering fuzes and fuze components on time. Difficulties that could be

attributed to the pre-award process included problems with statements of work (36 percent of the respondents), and an incorrect source selection process (26 percent of the respondents).

If post-award design changes were needed or there were difficulties associated with the Government-provided documentation, several ways to implement changes to the contract were identified. These include engineering change proposals by either the Government or contractor, contractor claims against the Government, termination of the contract, and bi-lateral modifications (the most common method). Contractors stated that submitting design changes and claims resulted in harsher adversarial relationships between the company and Government. Government respondents indicated that contractors were trying to obtain additional time or compensation in requesting changes to the contract. To decrease the adversarial relationship created by introducing changes into a contract, the survey participants advocated direct communication between the Government and contractor concerning Government requirements and needed changes.

Information was solicited from prime missile contractors concerning fuzes provided as Government Furnished Property (GFP), and problems associated with this process. The ABC case of the defaulted fuze contractor (Chapter IV) shows the impact that a small dollar item such as a fuze can have on contractors, Program Managers, Contracting Officers,

and others. The missile contractors who responded to the questions indicated that obtaining the mechanical fuzes was a major issue, whether the fuze was provided as GFP or subcontracted by the prime contractor. Advances in electronic fuze technology and fuze components are being investigated as an alternative to the mechanical design that may make obtaining fuzes easier. The issues surrounding the change in technology from mechanical to electronic are discussed in Chapter IV and recommendations are presented in the next chapter.

5. Contractor and Government Relationships

Survey responses have established a direct correlation between adversarial relationships and problems with Government documents, contract types, and contractor performance. Over 50 percent of the contractors and Government participants confirmed that adversarial relationships or inadequate training exist. A small minority, 20 percent, were satisfied with the interpersonal business relationships.

Inter-Government relationships were also characterized as adversarial by some respondents. Two main suggestions were made to improve relationships: better communications, and long-term relationships with suppliers and contractors that result in teamwork. Recommendations from the survey

respondents on ways to improve relationships are included in the next chapter.

6. Improvements to the Fuze Acquisition Process

Improvements that can be made in the fuze acquisition process correlate directly to the issues discussed above. Fundamental recommendations provided by the survey respondents were

- Use Total Quality Management techniques, including establishing long-term relationships between customers and suppliers
- Implement *best value* criteria in the pre-award acquisition process
- Emphasize performance specifications over "build to print" whenever possible
- Streamline the acquisition process
- Provide incentives to contractors for high quality products with timely delivery.

Improvements in any of these areas will also improve Government-contractor relationships.

The obvious conclusion is that the fuze acquisition process can be enhanced though several avenues. The acquisition process affects the quality of Navy weapons. It also affects a substantial cross section of the fuze population: small and large businesses, Procuring Contracting Officers and contract specialists, Program Managers, Technical Managers, prime missile contractors, and other matrix organizations.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. GENERAL SUMMARY

Chapter II has provided general information on conventional fuze technology and the relationship between fuze components and missile systems. Fuze components were briefly described, including the assemblies needed for fuze operation, detonation, and safety. The decrease in the number of fuze contractors conducting business with the Naval Air Warfare Center Weapons Division (NAWCWPNS) was discussed, along with high lot acceptance failure rates. These changes in the fuze industrial base are creating major problems for NAWCWPNS.

Chapter III discussed the fuze acquisition process from a NAWCWPNS perspective. The NAWCWPNS Procurement Department consists of technical support divisions for various kinds of customers. The relationship between the acquisition process and responsible officials was described in detail, along with the acquisition process itself, both pre-award and post-award.

Chapter IV described several Department of Defense (DOD) studies concerning the problems facing the overall military industrial base and the fuze industrial base. Three primary recurring acquisition issues have caused problems for the military in general and for NAWCWPNS fuze acquisitions specifically.

- Government specifications
- Awarding fixed-price development/low rate production contracts
- Adversarial atmosphere in the Government procurement system

Chapter V reported the results of a survey of fuzing community experts which elicited their opinions on the fuze industrial base and the acquisition process. A total of 15 questions were asked, grouped into six categories.

- Fuze industrial base
- SOWs, specifications, military standards, and drawings
- Contract award process
- Contract performance
- Relationships between Government and contractor personnel
- Suggested improvements to the fuze acquisition process

The survey results are consistent with results of previous studies, and confirm that serious problems are resulting in decreases in the military industrial base capability. From the information collected for this study, conclusions and recommendations are provided below.

B. CONCLUSIONS

The purpose of this study was to identify and propose solutions to problems related to the fuze industrial base at the Naval Air Warfare Center Weapons Division. The primary

research question has been: what are the key problems facing the fuze technology industrial base and how can these problems be resolved? Information documented in the previous chapters provides at least partial answers to this question.

1. Decreases in the Fuze Industrial Base

The fuze industrial base will continue to decrease as a result of the reductions in the defense budget. However, other contributing factors should be mitigated.

Reductions in defense budgets and the changing world environment are recent phenomena and not addressed in previous studies concerning the decreasing military industrial base. Yet, in the survey conducted for this study, over 50 percent of the contractors and Government personnel who responded stated that forthcoming changes in the defense structure will directly affect the fuze acquisition base.

2. Ambiguous Government Specifications

Ambiguous or erroneous Government statements of work and "build to print" specifications have resulted in increased costs, mid-contract changes, and program delays in both fixed-price and cost-reimbursement contracts.

In studies reported in Chapter IV, Government specifications were repeatedly noted to be ambiguous and a major problem for the industrial base. Analysis of several NAWCWPNS fuze contracts revealed that design and detailed specifications are used consistently for fuze acquisition.

However, the dozens of detailed specifications have not guaranteed NAWCWPNS reliable fuze components. Approximately 65 percent of the survey respondents reported that design flexibility would enhance fuze development and reduce program costs. Design flexibility has been limited in the past to the rigid Engineering Change Proposal approval process.

3. Contract Award Process

Reliance on *low acceptable offeror*, Firm-Fixed-Price (FFP) contracts for fuze development, along with low production rates, are inadequate to meet the customer's and contractor's needs, and result in contract terminations, claims, and numerous modifications to the original contracts.

Analysis of the survey results, contract data, and interviews confirms that fuze acquisitions have historically been awarded on the basis of price and/or have used FFP contracts. Both contractors and Government respondents acknowledged that low price does not equate to a "best value" product. Neither contractors nor Government personnel are able to predict fuze design changes that will be needed during development and transition to production. Thus it is not possible to write a "fixed" price contract that accurately reflects the costs of changes. As a result, modifications to fixed-price contracts are required routinely during the contract's life.

4. Contract Performance

Contract performance has regressed as a direct result of difficulties with specifications and the source selection process.

Contractors and Government personnel report that they have experienced increases in costs, program delays, and disruptions as result of inadequate or faulty specifications. Fuze acquisition delays have seriously affected prime missile contractors and Program Managers. Additionally, awards based on low price have not yielded the technical expertise and fuze reliability essential for missile systems.

5. Adversarial Relationships

Adversarial relationships between Government and industry are intensified by faulty specifications, inappropriate contract types, and inadequate performance.

One of the principal problems for the military industrial base is the adversarial relationship between the Government and industry. Previous research data and this study's survey results substantiate that the industry-Government adversarial relationship persists. In addition, adversarial relationships also are formed within the Government and among Government personnel. When problems are encountered in specifications, the contract type, the source selection process, or either Government or contractor

performance, discord between agencies and contractors increases.

C. RECOMMENDATIONS FOR THE FUZE ACQUISITION PROCESS

The purpose of this section is to recommend strategies that can be implemented to improve the fuze acquisition process. The final survey question requested suggestions for improving the overall process. These suggestions have been consolidated and are documented below. Some of the proposed changes can be implemented at the NAWCWPNS level. The implementation of others must be done either by contractors or by other agencies.

1. Decreases in the Fuze Industrial Base

Long-term Government-industry relationships must be established using conventional acquisition strategies such as contract options, since multi-year funds and long-term supplier commitments are not feasible.

Long term customer-supplier relationships were proposed by both Government representatives and contractors as a way to stabilize the industrial base and to provide an incentive for contractor investment. Multi-year and multi-funded programs were proposed as a way to implement this suggestion. The Federal Acquisition Regulation (FAR) defines a multi-year contract as lasting "more than one year but not in excess of five year's requirements, unless otherwise authorized by statute." But the FAR also specifies that

multi-year funding requires Congressional authorization and appropriations for more than one fiscal year. [Ref. 10:part 17.101] Congressional approval for multi-fund programs has been only rarely granted, and then only for major weapon systems programs. Long-term contracts with appropriated multi-year funding cannot be anticipated due to the requirement of obtaining Congressional approval. However, NAWCWPNS should continue to use contracts with options for renewal in subsequential years, when feasible.

A related research question is that of the minimum sustaining rate of fuzes for economical development and production. The most economical rate was not determined, since survey respondents and those who were interviewed noted that production capability varies from small to large businesses, production rate capability depends on the type of fuze, and changing fuze technology from mechanical to digital alters the rate that will be economical. Standardization of fuze components is proposed to permit consolidation of fuze units and larger production rates.

2. Ambiguous Government Specifications

Statements of work, specifications, and documentation must be streamlined to allow contractor flexibility in designing and implementing reliable commercial products.

Performance specifications should be used for missile fuze requirements, to provide boundaries on form, fit, and

function, but not specify how the work must be accomplished. These specifications would replace the design specifications traditionally used for fuze acquisition, which require that changes be approved by the Government prior to implementation. With performance specifications, the contractor acquires flexibility in design and development, yet reduces the need for Government approval of necessary changes.

One strategy would be to adopt a pilot program similar to the Air Force's Mil-Prime contracting methodology which uses tailored performance specifications. With its Mil-Prime program, the Air Force sets minimum requirements that contractors must meet. The contractors include in their contract proposals ways to meet or exceed these requirements. Contractors also can suggest changes to Government requirements and documentation that may result in lower costs without jeopardizing the quality of the product or contract award.

3. **Contract Award Process**

Best value source selection should be implemented and improved in contract awards for fuze development and transition to production.

A majority of Government and contractor survey respondents strongly supported the *best value* contracting process for fuze development. The *best value* acquisition approach requires that contracting and technical managers

collaborate to formalize the evaluation criteria for award, and contractors are required to provide very detailed proposals. Although *best value* awards require more Government and contractor effort at the beginning of the acquisition process, post-award changes should be reduced and the reliability of the final components increased.

4. Contract Performance

Financial incentives should be included in contracts to encourage high quality contractor performance.

The implementation of incentive fee and award fee fuze contracts could benefit both contractors and Government programs. Both Cost-Plus-Incentive-Fee (CPIF) and Fixed-Price-Incentive Firm (FPIF) contracts provide ways to share cost increases between the contractor and Government. This sharing of additional costs allows some flexibility on the part of both the contractor and Government, but also maintains an incentive to control costs. The FPIF award places the majority of cost risk on the contractor while the CPIF award moves the majority of cost risk to the Government. The use of the appropriate type contract, whether CPIF or FPI, should be based on the type and level of fuze development work required under the contract.

The use of award fee contracts has been limited in the past to multi-million dollar projects. Based on the critical nature of missile fuzes, the reliability issues raised in this

study, and the cost impact to larger programs, Cost-Plus-Award-Fee (CPAF) contracts should be implemented whenever feasible, for fuze acquisition. The award fee should be structured around the Technical Manager's requirements for managing the contract and limiting costs. Under CPAF awards, the contractor who provides a quality product and is responsive to contractual issues will to receive a higher award fee than a contractor who provides minimal efforts.

5. Adversarial Relationships

More direct communication between contractors and Government and among various Government agencies must be implemented, to minimize adversarial relationships.

Relationships between contractors and the Government, and among Government agencies can be improved by face-to-face communications whenever feasible. Recommendations for improved communications include the following.

- Continue to hold pre-procurement meetings between acquisition personnel and TMs
- Hold pre-procurement conferences at which contractors can provide input and gain better understanding of Government technical and contractual requirements
- Improve attendance at post-award conferences by both Government and contractor representatives
- Utilize face-to-face meetings or video conferences for major contract changes
- Document and distribute to participants the minutes of all meetings, to avoid misunderstandings

- Perform regularly-scheduled program reviews and program updates

D. RECOMMENDATIONS FOR ADDITIONAL RESEARCH

The study reported here has answered a number of critical questions related to the shrinking of the missile fuze industrial base. It also has brought to light several areas where further research should be fruitful. These areas include the following.

- A cost-benefit analysis of replacing mechanical type fuzes with state-of-the-art electronic components should be performed.
- The use of standard fuze components with tailored assemblies should be evaluated, to determine whether this procedure will yield a higher production run of standard parts.
- A cost-benefit analysis approach should be used to determine whether *best value* awards are preferable to *low acceptable offeror* awards for acquiring fuzes.
- Concurrent engineering techniques should be studied as a way to improve the fuze and missile integration process.
- The Pilot Mentor-Protege Program that matches small disadvantaged businesses and large businesses for long term commitments (five to nine years) should be reviewed and evaluated as a way to increase the base of small suppliers for major missile contractors.
- Establishment of a mobilization base for selected, qualified fuze contractors should be studied as a way to respond rapidly to future military emergencies.

APPENDIX A

ACRONYM LIST

AAAM	Advanced Air-to-Air Missile
ABF	Advanced Bomb Family
ACO	Administrative Contracting Officer
AIWS	Advanced Interdiction Weapon System
AMRAAM	Advanced Medium-Range Air-to-Air Missile
BAFO	Best and Final Offer
CBD	Commerce Business Daily
CICA	Competition in Contracting Act, 1984
CPAF	Cost-Plus-Award-Fee (contract)
CPFF	Cost-Plus-Fixed-Fee (contract)
CPIF	Cost-Plus-Incentive-Fee (contract)
DCMC	Defense Contract Management Command
DSMC	Defense Systems Management College
DoD	Department of Defense
ECP	Engineering Change Proposal
ESAD	Electronic Safe and Arming Device
FAR	Federal Acquisition Regulation
FFP	Firm-Fixed-Price (contract)
FPI	Fixed-Price Incentive (contract)
GPF	Government-Furnished Property
HARM	High-Speed Antiradiation Missile
JDAM	Joint Direct Attack Munitions
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command

NAWCWPNS	Naval Air Warfare Center Weapons Division, China Lake, California
NPS	Naval Postgraduate School
PCO	Procuring Contracting Officer
PM	Program Manager
PR	Procurement Request
QAR	Quality Assurance Representative
RAM	Rolling Airframe Missile
RFP	Request for Proposals
S-A	Safety and Arming Device
SB	Small Business
SOW	Statement of Work
TM	Technical Manager
TQM	Total Quality Management
USD(A)	Under Secretary of Defense (Acquisition)

APPENDIX B

LIST OF PERSONS INTERVIEWED

1. Interview between Scott Greenmun, Engineer, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 4 December 1992.

2. Interview between Blaine Manson, Associate Department Head Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 4 December 1991.

3. Interview between Sharon Ballenger, Contract Specialist, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 19 December 1991.

4. Interview between Susan Scott, Procuring Contracting Officer and Division Head, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 19 December 1991.

5. Interview between Sandy Scharn-Stevens, Procuring Contracting Officer and Division Head, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 18 December 1991.

6. Inteview between Russell Spindler, Legal Counsel, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 18 December 1991.

7. Interview between Mike Tyler, Branch Head, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 18 December 1991, and 10 March 1992.

8. Interview between Steve Fowler, Fuze Safe-Arm Division Head, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 18 December 1991.

9. Interview between Eric Saiken, Associate Division Head, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 18 December 1991.

10. Interview between John Gallagher, Branch Head, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 27 February 1992.

11. Telephone conversation between between Jean Piazza, Small Business Specialist, Naval Air Warfare Center Weapons Division, China Lake, CA. and the author, 16 April 1992.

12. Interview between Rena Mueller, Procuring Contracting Officer, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 19 December 1991, and 10 March 1992.

13. Telephone conversation between Diane Foucher, Procurement Analyst, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 16 April 1992.

14. Telephone conversation between Dave Deneke, Contracts Manager, Hughes Aircraft Company, Missile Systems Division, 5433 Fallbrook, Bldg. 262, C25 Conoga Park, California, and the author, 8 April 1992.

15. Telephone conversation between between Don Bergeron, Contracts Manager, Texas Instruments, 2501 South Highway 121, Louisville, Texas, and the author, 9 March 1992.

16. Telephone conversation between Joe Clendenen, Contracts Manager, Motorola Inc., Government Electronics Group, 8220 East Roosevelt Street, Scottsdale, Arizona, and the author, 8 April 1992.

APPENDIX C

EXAMPLE QUESTIONNAIRE USED FOR SURVEY

Company Name:_____ **Bus. Size:** Small or Large

Name:_____ **Position:**_____

Yrs of Fuzing Experience:_____ **Programs:**_____

Yrs of DoD Experience:_____

My Company Was Awarded Contracts From Naval Air Warfare Center, China Lake. **YES** **NO**

Industrial Base

1. What do you feel is causing the DoD fuze industrial base shrinkage?

2. In the future, will your company be pursuing more or less DoD business and why?

3. To assure delivery of reliable fuzes, what incentives or programs should the Government offer to encourage contractors to propose on future DoD contracts?

Statements of Work/Specifications/Standards/Drawings

1. What are the primary problems affecting Government Statements of Work, Specifications, Drawings, and Standards that you find most prohibitive?

2. Do Government Specifications allow flexibility in your design and production of fuzes? If not, please suggest what changes should be made in this area?

Contract Award Process

1. What type of contract award processes have been used in the awarding of fuze contracts? (For example, IFB, FFP-low offeror, Other Than Full and Open Competition (Sole or Limited Source), Cost contracts, Competitive Source Selection, Best Value)

2. What are the benefits or drawbacks to the Government award process?

3. How can Naval Air Warfare Center, China Lake improve the procurement award process?

Performance

1. In your opinion, what are the major difficulties associated with performance of fuze contracts?

2. What difficulties in the performance can be attributed to pre-award actions by the Government?

3. What have you done to resolve those difficulties? For example, did you submit claims, engineering changes proposals or request changes to the contract?

Prime Missile Contractors

1. Are fuzes provided as "Government Furnished Property" or "Make or Buy" under your contract? And what problems have experienced in this area?

Relationships

1. In your opinion, are there any weak (i.e. lack of training/knowledge) or adversarial relationships in your dealings with the Government (i.e. PCOs, Engineers, ACOs, QARs, Auditors, Program Managers, NAVAIR or NAVSEA Sponsors)?

2. What can be changed to encourage better relationships?

Improvements

1. In your opinion, if you could improve or change any three areas in fuze contracting, what would they be and why?

LIST OF REFERENCES

1. Bingaham, Jeff, and McCain, John, *Detterence in Decay: The Future of the U.S. Defense Industrial Base*, Washington, D.C., May 1989.

2. Lee, R.G., and others, *Guided Weapons*, Brassey's Defence Publishers, 1983.

3. Advisory Group for Aerospace Research and Development (AGARD), *Missile Aerodynamics*, AGARD Conference Proceedings No. 493, October 1990.

4. "Clever Fuzes Make Ammunition Intelligent," *Amarda International*, February 1988.

5. Nicholas, Ted, and Rossi, Rita, *U.S. Missile Book-1992*, Data Search Associates, October 1991, p. C-4.

6. Fowler, Steven E., *A Study of Navy Acquisition of Safety-Arming Devices*, 14 December 1990.

7. Naval Air Warfare Center Weapons Division, *Fuze Development Strategy for Safe-Arm Devices*, 1991.

8. Department of Defense Instruction 5000.2, *Defense Acquisition Management Policies and Procedures*, February 23, 1991.

9. United States Department of the Navy, *NAVSO P-2457, RDT&E Acquisition Management Guide*, January 1989.

10. *Federal Acquisition Regulation*, 1991 Edition, Department of Documents, U.S. Government Printing Office, Washington, D.C.

11. Department of the Air Force, Air Force Institute of Technology, *Compendium of Authenticated Systems and Logistics Terms, Definitions and Acronyms*, April 1981.

12. Interview between Diane Foucher, Procurement Analyst, Naval Air Warfare Center Weapons Division, China Lake, CA, and the author, 16 April 1992.

13. Interview between Jean Piazza, Small Business Specialist, Naval Air Warfare Center Weapons Division, China Lake, CA, and the author, 16 April 1992.

14. *Armed Services Pricing Manual*, Volume 1, Government Printing Office, Washington, D.C., 1986.

15. Naval Postgraduate School, NPS-54-87-003, *An Analysis of Reasons Companies Refuse to Participate in Defense Business*, by D.V. Lamm, March 1987.

16. *Report to the Secretary of Defense, Bolstering Defense Industrial Competitiveness*, by Under Secretary of Defense (Acquisition), July 1988.

17. Defense Management College, *Defense Procurement Industrial Base Study: Why Firms Are Leaving the Defense Market*, 5 December 1990.

18. Office of the Deputy Director of Defense Research and Engineering, *Report on the DoD Fuze Industrial Workshop, Draft*, Defense Management College, March 1990.

19. Whelan, John W., *Federal Government Contracts, Cases and Materials*, The Foundation Press, Inc., 1985.

20. *Federal Contracts Update*, Volume 2, No. 3, by T.J. Madeen and W.L. Walsh Jr., Venerable, Baetjer, and Howard's, December 1987.

21. General Dynamics, *The World's Missile Systems*, Pomona Division, August 1988.

22. Interview between Russel Spindler, legal counsel, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 9 March 1992.

23. Naval Air Warfare Center Weapons Division, *Drawing of S-A* by Mike Tyler, Ordnance Department, May 11, 1992.

24. Fowler, Steven, "State of the Health, Development Strategy for Safe-Arm Devices, and Fuze Programs," presented to Naval Air Systems Command, September 1991.

25. Interview between Sharon Ballenger, Contract Specialist, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 19 December 1991.

26. Interview between Rena Mueller, Procuring Contracting Officer, Naval Air Warfare Center Weapons Division, China Lake, CA., and the author, 19 December 1991, and 10 March 1992.

27. Knight, Cedric, Cdr., "List of Fuze Contracts at Naval Air Warfare Center Weapons Division" of 25 October 1990.

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